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GERMAN PSYCHOLOG

OF

TO-DAY

THE EMPIRICAL SCHOOL

Théodule BY

TH. RIBOT

DIRECTOR OF THE REVUE PHILOSOPHIQUE

TRANSLATED FROM THE SECOND FRENCH EDITION

BY

JAMES MARK BALDWIN, B. A.

LATE FELLOW PRINCETON COLLEGE

WITH A PREFACE

BY JAMES McCOSH, D.D., LL.D., LIT.D.

NEW YORK
CHARLES SCRIBNER'S SONS
1886

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TRANSLATOR'S NOTE.

THE translation of M. Ribot's *Psychologie allemande contemporaine* was undertaken with the feeling that no greater service of the kind could be rendered to the "new psychology." The second edition has been scrupulously reproduced, since, as the author writes in a note sanctioning the translation, "it alone is abreast of contemporary work." There are no additions except some English bibliographical notes.

The translator wishes to express his thanks to Prof. Alexander T. Ormond and Prof. H. C. O. Huss for helpful suggestions, and to his friend Mr. W. R. Huston for assistance with the proof-sheets.

J. M. B.

PRINCETON, *April*, 1886.

PREFACE TO THE AMERICAN EDITION.

AMERICAN and English students will be grateful to have M. Ribot's valuable work in their own tongue by a competent translator. It contains the combined result of careful observations, experiments, and calculations which can not be obtained otherwise, except by reading innumerable books and monographs most difficult to collect. His interpretations and criticisms also are original and profound.

If we would properly estimate the exact nature and functions of what is called Physiological Psychology, we must adhere resolutely to two positions, which to some may seem opposed, but are really confirmatory of each other.

I.

It is by self-consciousness that in the first instance, and in the last instance, and throughout, we know the actings of the mind. We assume, what every one admits, that there are a special set of phenomena, that is, observed facts, which we denominate mental or psychical: such are sensations, perceptions, judgments, hopes and fears. These are not perceived by the senses. No man ever saw a recollection or touched an emotion. We have an inward as well as an outward sense, and we are conscious of them. We are more, we are conscious of them as acts of self. They are not memories or feelings indefinite, or of our neighbors, but of ourselves. We thus know self always in particular modes and activities. More specifically we know self (1),

or what is the same thing, as having being.
(2), as having being independent of our obser-
It does not exist because we notice it, but we
cause it exists. It is (3), known as having
ting and being acted on.

r possesses these attributes may be regarded as
(from *subsisto*); not meaning thereby that it has
substratum, which is the creation of metaphy-
atter is a substance because it has existence,
dependent of the observing mind, and is known
ng resisting power. Mind is also a substance,
possesses these three properties, all of which are
as. While mind and matter may both be called
, they are different kinds of existences. We
a by different organs; the one by self-conscious-
ther by the senses. Again we know them as
altogether different properties; the one as per-
easoning, feeling, willing; the other as extended
ising energy. The properties of the one can not
ted of the other. Thinking and feeling have no
hat stone; nor have softness, hardness or gravity
als.

n observe the actings of the known self and get
l facts. We can systematically observe them and
hem to a process of abstraction and generalization,
is called induction, and thus construct a science
called Psychology. Aristotle is the founder of this
nd brought out and exposed to view such qualities
ion, association, phantasy, memory, reminiscence,
on active and passive, besides orective or motive
Since the days of the Stagyrite, the inductive psy-
constructed mainly on the evidence supplied by
ness have been innumerable, and have all con-
ore or less truth, which has landed us, as all truths
ysteries.

Besides the knowledge which consciousness gives us directly it enables us indirectly to know what passes in the minds of others by means of their deeds, speeches and writings, which we can understand, because we are conscious of like states in ourselves. We can understand the deeds of Achilles, or the devils of Milton, because we have the same elements within ourselves. A skillful analyst could construct a psychology out of Shakespeare, or out of the Hebrew and Greek Scriptures.

In Psychology as the science of the soul, and not of the mere brain and nerves (which belong to physiology), we start with conscious acts, we observe them as we proceed, and our final appeal is to them. The universally recognized distinctions between sensation and perception, between the memory and the imagination, between simple apprehension and judgment, between the understanding and the reason, between the judgment and the feelings, between the reason and the will, between desire and volition (more important than any discovery yet made by the observation of the brain) were all perceived and defined by inward inspection.

There can therefore be a psychology constructed out of the data supplied by self-consciousness. There can not be a science of the mind without such data. Any professed psychical science which does not include the actings of the conscious self, its perceptions, its memories, its reasonings, its determinations is a physiology and not a psychology; it may exhibit the laws of the brain and nerves, but not of the judging and feeling soul. A science of the mind can no more be constructed by the senses than a science of matter by the inner consciousness. Dr. Tyndall says, "Let the consciousness of love be associated with a right-angled spiral motion of the molecules of the brain, and the consciousness of hate with a left-handed spiral motion, we should then know when we love that the motion is in one direction, and when we hate that the motion is in the other, but the *why* would still remain unanswered;" not only so, but without self-consciousness we could never know that there was love, or that there was hate, or that they had any connection with the motions of the brain.

II.

But while all this is true, on the one hand, and as important as it is true, it is not to be forgotten on the other, that mind and body, as the most determined spiritualists admit, are closely connected, are, in fact, mutually dependent. Many of our psychical states, particularly our sensations and sense perceptions, are produced by bodily action, cerebral and nervous. Without the bodily senses we could have no knowledge of anything external to the mind, and so far as we can see even our mental experiences would be very limited. Again, our intellectual and emotional states have all an effect less or more marked on the body through the brain and nerves. Every thought and every emotion has an influence on the cells of the gray matter at the periphery of the brain, and this may be diffused through the whole frame to promote or injure the health. Not only so, but as substances are known by their acts, we may know more of mind than we can do by mere self-inspection, by its action on the cerebro-spinal mass.

The peculiar excellence of this new branch of inquiry is that it uses the same means as those by which physical science has reached such certainty, particularly experiments conducted by instruments devised for the purpose, and can test the results reached by measurements capable of being expressed numerically. These have therefore a definiteness which can not be secured by the more immediate but looser observations of consciousness. I claim, indeed, that we have so far a compensation for this, in that we have a more direct and a much fuller knowledge of mind by the inner sense; but this can not be put in so scientific a form. The result we reach is that we are to attain a knowledge of mind by the judicious combination of the two processes, the one aiding the other. But the impression should not be left that we can gain a true knowledge of mind, of its lofty ideas, say of order and design, of perfection and infinity, or of its sentiments of reverence, benevolence, hope and love by mere experimenting on its material adjuncts which act and are acted upon by it.

I do not regard this physiological psychology as constituting a new psychology, as is claimed by M. Ribot. It is a new and promising branch of the old science. It has not altogether been overlooked in ages past. The founder of Psychology, Aristotle, treated of the senses, and sought to determine the functions of each. Descartes made observations on the brain, and Berkeley showed that we can not discern distance directly by the eye. The Scottish school has given attention to the same inlets; and its principal masters, Reid, Brown, and Hamilton were acquainted with the most advanced physiology of their day. But it is admitted on all hands that science now requires and has vigorously commenced a more searching examination than our older inquirers could institute as to the mutual relations of mind and brain. Young inquirers are rushing into the field as adventurers do to a newly discovered mine.

There are certain departments in which physiological-psychology has made valuable discoveries and will make more, and these of increasing value. In particular:

1. By it and by it alone we can investigate the bodily senses, including the sense of temperature, in all of which there are still mysteries whose solution will throw light on the mode of the mind's action. It will, I believe, at no distant date be settled whether each of the senses, as is probable, has a special seat in the brain.

he relation of language, as a mental exercise and ulation, to the brain, specially to the third convolu- the left side of the brain as discovered by M. Broca, accurately determined.

here are laws of the association of ideas which are mental, and these have been approximately ascer- Aristotle made them Contiguity, Resemblance, and t; perhaps they may be more fully classified as ity and Correlation, including Resemblance, Con- d others. But in explaining our experience we meet ifficulties: for example, we find that the flow of ; is stayed at one time, as when we are wearied at ut is resumed at another time, as when we are fresh morning, and this no doubt is to be explained by laws not yet discovered.

is of importance for many scientific purposes to ne the rapidity of thought and feeling in ordinary raordinary circumstances, and also to find out how idity may be hastened or slackened. We already pproximately what time is occupied by a sensor the transmission of an excitation to the brain, and e occupied by the motor nerve in the voluntary ; and there have been attempts at the measurement thought and feeling, of choice and discernment t), and of memory (Ebbinghaus).

n interesting field is opened in discovering at what tain acts begin to be performed and certain ideas rise, as, for instance, at what age infants fix their objects or think of space and time, right and wrong. nning has been made in these investigations by , Spencer, Stanley Hall, and they will be followed rs.

most systematic and valuable researches on the gen- ject have been made by German investigators. Much dge was imparted and much impetus to inquiry by the great work of John Müller on Physiology. Speci works began with Herbart of Leipsic, who sought to app mathematics to psychical phenomena. Little positive trut was thereby discovered, as mathematics, which deals onl with quantity and position, can throw little light on th operations of the mind; but inquirers were taught to see scientific definiteness of results. Weber made curiou discoveries as to the sensitiveness of different parts o the body such as the tongue and back. Fechner, in hi Psychophysik, has made some important observations as t the relation between the external excitation and the psychic perceptions, and these have been tabulated. It has bee difficult to reach a law applicable to all the senses. It ma be remarked that this subject will not be cleared up thor oughly till the inquirers take the view of causation give by John S. Mill, that a cause always consists of two o more agents. The external excitant does not constitute th entire cause of the perception, but the two acting and r acting constitute the cause of the effect that follows.

Lotze was a man of genius, and has had great influen both in Germany and in this country. He has called i Local Signs to account for sense perceptions in space. believe that there is truth in his theory, although he ha mixed it up with metaphysics; but the precise nature o these Local Signs, which appear to me to be physiologic and not psychical, will require to be definitely determin

The observations and speculations of Fechner and Lot have raised a great many discussions, and earnest inquir have reached different results. Hering of Prague ha attacked the psychophysics of Fechner at nearly every poi denying that he has been able to establish any of his la On the other hand the latter has been defended in some o his positions by Delbœuf, who seeks, by experiment, t establish certain laws of his own discovery.

Helmholtz, the great physicist, has thrown himself in this discussion and has inquired particularly into the origin of our idea of space. He divides the theories into those of the nativist and empiricist, he himself holding the latter. Under the former he includes the *a priori* theory of Kant, which supposes that the mind adds to the knowledge acquired through the senses; a view which can not be entertained by those of us who oppose the doctrine that the mind imposes forms on things. On the other hand I can not see that the idea of space can be obtained from a gathered induction or from a series of experiences no one of which contains the idea. We may maintain that the mind by its native power discovers at once objects in space and occupying space; and by an easy process of abstraction we separate the space from the objects it contains.

Wundt is the most eminent living representative of the school of physiological psychology. When he brings in metaphysics, however, exception may be taken to some of his conclusions. Thus he will find few to follow him when he says that our sense perceptions are the conclusions of a process of reasoning instead of being immediate, as if we could by any legitimate process of reasoning get the perception of an extended thing from that which has no extension. I am pleased to find that he is abandoning this theory (see p. 220 of this treatise) in favor of a theory of apperception, a word used by Leibnitz, and pointing to a truth. But in treating of his own subject, the relation of the cerebro-spinal mass to mind, he has shown much ability, discrimination, and wisdom; as he has also done in measuring the time occupied by nervous action and reaction.

We have now a clear and comprehensive account of the German observations, experiments, and discussions in this work of M. Ribot, with which every student of psychology should be acquainted. I am not sure that he has set a sufficiently high value on the observations of consciousness; but just here another of his excellencies is seen: he has

carefully separated psychology, which is a science of
vation, external and internal, throughout from all
physical speculation.

The work has been well translated by one who
distinguished student and Fellow in Mental Scie
Princeton College, and who has since studied und
great masters in Germany.

JAMES McC

PREFACE

TO THE SECOND EDITION.

WORKS published in Germany during the last six years have made it necessary to revise this volume. To simplify it, quite a little has been suppressed. The principal additions have reference to recent monographs on psychology, new discussions of the law of Weber, and work done in the psycho-physical laboratory of Wundt. The chapter devoted to Wundt has also been worked over in view of the second edition of his *Physiological Psychology*, of which a French translation is being prepared. It has seemed better, therefore, not to give a detailed analysis of the book, but to devote more space to works which have not been translated, and probably will not be.

February, 1885.

CONTENTS.

TRANSLATOR'S NOTE, ... v

PREFACE by James McCosh, D. D. LL. D, ... vii

PREFACE TO THE SECOND EDITION, ... xvii

INTRODUCTION, ... 1

The old psychology—The new psychology—Its principle—Its method—Physiological psychology—Comparison of English and German psychology; general characteristics of the latter—Object of the book.

BEGINNINGS: HERBART, ... 24

I. Principles of the psychology of Herbart—II. Mathematical method: static and mechanic of mind—III. Feeling—IV. Critique of the psychology of Herbart.

SCHOOL OF HERBART AND THE ETHNOGRAPHIC PSYCHOLOGY, 49

I. Influence of Herbart: His principal disciples—II. Ethnographic psychology: Th. Waitz—III. Lazarus, Steinthal, and their views.

LOTZE: THEORY OF LOCAL SIGNS, ... 68

I. In what sense Lotze is an empirical psychologist—Metaphysical tendencies of his spirit and method—Unfortunate consequences—II. Object of the theory of local signs: general sketch of the theory—Extension referred to intensity—III. Special study of visual and tactile local signs—Importance of Lotze's theory: its critics.

EMPIRICISTS: ORIGIN OF THE NOTION OF SPACE, 96

e problem—I. Tactile space—Nativist theories:
eber, Stumpf—Empirical theories—II. Critical
e question—III. Visual space—Nativist theory:
of identity (Müller); of projection (Volkmann,
gel, &c.)—Theory of Panum; theory of Hering,
-The empiricists—Theory of Helmholtz, of Wundt,
l and association theories—Critical study of the
lvantages and defects of the empirical position.

PSYCHOPHYSICS, ... 134

ects of psychophysics before Fechner—II. Psycho-
earches: observations of Weber—Three methods
III. Experimental determination of the *smallest per-*
rence, for sensations of touch, muscular effort, temp-
nd, light—IV. Experimental determination of the
eptible sensation in the same cases—V. The logarith-
VI. The critics of Fechner, Bernstein, Brentano,
esearches of Delbœuf—Objections to the mathema-
sion of the law, to its experimental basis—Differ-
en Weber's and Fechner's laws—*Résumé* of the ques-
ssion of Wundt and Zeller as to the possibility of
psychic facts.

'HYSIOLOGICAL PSYCHOLOGY, ... 188

eneral conception of psychology and his method—
physiology: specific energy of the nerves; criticism
ery—III. Perception—Extension referred to a psy-
ynthesis—Function of local signs and movement—
ct notions—V. Apperception—VI. Feeling in gen-
The æsthetic feelings—VIII. Moral feelings—IX.
eelings—X. Will and apperception: liberty and
XI. Consciousness.

OF PSYCHIC ACTS, ... 250

es on this subject to the present—II. Determina-
physiological time in different conditions. Mean
xperiment. Probable duration of the simplest in-
s—III. Second period of psychometric research—
nsciousness—Duration of different kinds of associa-
ment—Pathological variations—Epitome of results.

CONCLUSION, ... 287

I. Condition of psychology in Germany: Study of additional questions in natural psychology—Horwicz, feeling prominent —Bretano: relation to Stuart Mill—Kussmaul—Stricker—Schneider: psychology of evolution, &c., &c.—II. Analysis of elements of sensation (Helmholtz)—General results and résumé of the work.

GERMAN PSYCHOLOGY OF TO-DAY.

INTRODUCTION.

THIRTY years ago, at most, if any one had dared maintain, in this country, that psychology was still in a state of childhood, and had little prospect of growth, he would have been accused of paradox. One would have advised the critic to read again the works that have been devoted, since Locke, to the different manifestations of the human spirit, and the reply would have been judged sufficient.

To-day it would be no longer sufficient for any one. The point of view has changed, and many are disposed to think differently. In recognizing—as is just—that the old psychology has rendered service, has established some points definitely, shown in analysis a penetration and delicacy difficult to surpass, one refuses to see in all this more than attempts. The spirit of the natural sciences has invaded psychology and made it more difficult. One asks whether a collection of ingenious remarks, of fine analyses, of observations clothed in terms of elegant exposition, of metaphysical hypotheses set with precious truths, that must, by right, be forcible, constitute a body of doctrine, a true science;—whether it is not time to resort to a method more rigorous. Thus has arisen the separation, every day more apparent, between the old and the new psychology.

Although it has cut a good figure enough, the old psychology is doomed. In the new surroundings that have recently

p the conditions of its existence have disappeared.
hods do not suffice for the increasing difficulties of
k, for the growing exigencies of the scientific spirit.
mpelled to live upon its past. In vain its wisest
ntatives attempt a compromise, and repeat in a loud
that it is necessary to study facts, to accord a large
o experience.[1] Their concessions amount to nothing.
ver sincere their intentions; in fact, they do not
e them. As soon as they put hand to the work the
for pure speculation seizes upon them. Besides, no
n is possible of that which is radically false, and the
sychology rests upon an illegitimate conception, and
d perish with the contradictions that are in it. The
s that are made to accommodate it to the exigencies of
odern spirit, to work a change in its real nature,
only delusion. Its essential characteristics remain
ys the same; one can show it in few words. In the
place, it is possessed of the metaphysical spirit; it is
"science of the soul;" internal observation, analysis,
reasoning are its favorite processes of investigation: it
nts biological science, associates with it only in reluct-
and by necessity, and is ashamed to acknowledge its
. Feeble and old, it makes no progress, and asks only
e let alone, that it may spend its age in peace.

ch a conception is no longer vital. Its metaphysical
ncies exclude the positive spirit, forbid the employ of
ntific method, deprive psychology of the fruits of free
rch. It does not dare to assert itself as a study of
hic *phenomena* alone, distinct and independent. Yet

---

there more determined in Germany, some few Hegelians, and with
e disciples of the school that takes the name "spiritual realism,"
psychology a branch of metaphysics and despise natural psychol-
. We have no intention of combating these mystics; no discus-
s possible with them, because there is nothing common; neither
ples, methods, language, nor end.

this is a real necessity. In proportion as the old habits of mind are effaced, will we see, more and more clearly, that psychology and metaphysics, formerly confounded under the same title, presuppose intellectual aptitudes that are opposite and exclusive. We will perceive that talent in metaphysics bears an inverse ratio to talent in psychology; that henceforth, apart from some rare geniuses who combine the two perhaps, the psychologist should renounce metaphysics and the metaphysician psychology.

For the old school, since taste for internal observation and subtilty of spirit were exclusive signs of a call to psychology, the programme summed itself up in two words—observation and reasoning. Internal observation is, without doubt, the first step; there is always a necessary process of verification and interpretation; but it can not be a method. To maintain this is to forget or to disown entirely the conditions of a scientific method. If psychology can be constructed in this way, good eyes and fixed attention will suffice for the construction of physiology.

Subtilty of spirit is also too fragile an instrument to penetrate the compact and serrated line of the facts of consciousness. For the last two hundred years it has been testing. We owe to it good descriptions, excellent analyses; but its work is done. Its province now is simply details, shades of meaning, refinements, subtilties. And as far as it dare touch upon the profound, it will be only to heap up more delicate and hidden distinctions. It does not reach the general—*can never explain it.* Under these conditions the psychologist becomes a romancer, a poet of an especial kind; he seeks the abstract rather than the concrete; he dissects instead of producing, and psychology becomes a kind of literary criticism, very penetrating and acute, but nothing more. The study of psychic phenomena in their totality from the lowest form in animals to the highest in man is forbidden him. Such a psychology is incapable of referring

nifestations to the laws of life; it has neither full-
strength.

t strikes one, in fact, in the old psychology, is its
simplicity ; it is simple in its object, simple in its
It presents a character that is narrow, and, to
it in a word, childish. It lacks air and horizon.
ons are proposed in a shallow and insufficient form,
by a verbal method which approaches the scholastic.
solves itself into deductions, arguments, objections
plies. In this refinement of subtleties, always in-
g, we reach at last symbols only: all reality has
peared. In the solitary spirit that racks and torments
to draw everything from within, that meditates with
eyes, taking from without only what is necessary to
itself from death by inanition, a rarefied atmosphere
duced, that nothing living can breathe. The soul is
ted with wild visions.

any one who takes up these questions in their suc-
on, it is easy to show that this metaphysical preoccu-
on, this abuse of the subjective method and the reason-
powers, paralyze the best minds. The state of con-
ness isolated from that which precedes, accompanies
follows it, *i. e.*, its anatomical, physiological, and other
ditions, is nothing more than an abstraction ; and when
have duly classified it, referred it to a hypothetical fac-
which is itself attributed to a hypothetical substance,
t have we discovered, what have we learned? If, on
other hand, the state of consciousness be studied as part
a natural group whose elements mutually suppose one
ther, and are to be studied each apart and in its relation
he others, we rest in reality. We are not satisfied with
formula so dear to the old psychologists: "This is from
siology." But we take our own wherever we find it ;
receive instruction from all sides, and do not mistake for
ience the nomenclature of phantoms of our own making.

Too much reasoning: this is the impression that the old psychology makes upon the disciples of the new. Reasoning—that is confidence of the spirit in itself, and faith in the simplicity of things. The new psychology submits that the spirit ought to distrust itself, and believe in the complexity of things. Even in the less complex order of biological science, our inductions and deductions are baffled at each step. What *ought to be*, is not; what is inferred is not verified; where logic says yes, experience says no.

Do the representatives of the old psychology—and they are still many, though differing in shades of opinion—understand the position they have taken with reference to contemporary science? The physicist and the chemist trust themselves only in their laboratories: the biologist daily adorns his workshop with new machines, arms himself with all his weapons, multiplies his instruments and means of experiment, strives to substitute the passive and mechanical registry of phenomena for their subjective estimation, since the latter is always vacillating and uncertain. The psychologist, on the contrary, dealing with facts of the extremest complexity, is unable to begin again the work of his predecessors, or reconsider what is already well established, is compelled "to interrogate himself," without information, experience, apparatus, or means of procedure. If his work is a science, it must be confessed that it resembles nothing else that bears that name.

II.

The new psychology differs from the old in its spirit: it is not metaphysical; in its end: it studies only phenomena; in its procedure: it borrows as much as possible from the biological sciences.

We have tried elsewhere to show the advantages of a psychology without metaphysics, or, as has been said since,

: of the facts of consciousness, so vague, so fleeting, so
lt to fix. While objective phenomena are distin-
d from one another by their specific qualities, their
ns in time, and especially their form, figure, and all
quantitative determinations in space; psychical states,
in themselves, recognized in consciousness alone, have
nces only of quality and relation in time. Thus it
en the task of the new psychology from the first to
t to increase their determinateness, or, what amounts
same thing, the sum of their relations. It is here
e discoveries of physiology have been a great help.
g established that psychical movements are connected,
neral way, with the cerebro-spinal system, physiology
own more recently, that every psychical state is
bly associated with a nervous state, of which reflex
is the most simple type. This principle is uncon-
table for the majority of cases, in the highest degree
ble for the remainder.

s impossible for us to show here in detail that every
f consciousness is accompanied by a correlative well-
ined physical state. Some general indications of it

organism, movement, cries, gestures, secretions, vascular modifications. Yet, in the totality of the psychic life, there are certain states of consciousness of which this general position may be doubted. Do not reflection, abstract reasoning, exalted feeling, seem, as the old psychology maintains, to be manifestations of pure mind? This proposition can not be maintained. The psychic life is a continuity beginning with sensation and ending with movement. At one extreme we find sensation and images connected with physical states; at the other extreme, desire, feeling, and volition, also connected with physical states; can we suppose in the centre the existence of a *terra incognita* under other conditions and ruled by other laws? "It would contradict all we know of cerebral action to suppose that the physical chain leads abruptly to a physical chasm occupied by an immaterial substance which communicates the results of its work to the other end of the physical chain. . . In fact, there is no interruption in nervous continuity" (Bain). But plausible as this conclusion seems, psychology can do more than reason from an analogy founded on the continuity of natural law. In the first place, the most profound and abstract reflection is not possible without symbols that suppose a physical determination, feeble though it may be. Again, general physiology informs us that if something is produced, something decays; that the period of functional discharge is a period of disorganization, and that this biological law is applicable to the brain as to any other organ, to the work of the brain as to any other function. Let us notice, also, the production of heat which accompanies psychical activity (Schiff), modifications in the excretions produced by intellectual work (Byasson); and without accumulating details that would fill a volume, we can conclude—that every definite psychical state is connected with one or more definite physical events which we recognize well in most cases, little, or not at all, in others.

he arbitrary and barren hypothesis of two substances
g upon each other, let us substitute the study of two
omena which have, for each particular case, so con-
a connection that they can be most exactly designated
e phenomenon of a double face.

cordingly, the domain of psychology is specific: it
for its object nervous phenomena accompanied by
iousness, finding in man the type most easy of recog-
n, but bound to pursue the investigation through the
e animal series, however difficult. At the same time,
istinction between psychology and physiology is es-
hed. Nervous process in its simple aspect belongs
hysiology; nervous process in its double aspect
gs to psychology. There can be no hesitation in
where consciousness merges little by little into autom-
(habitude), and in cases where automatism merges
consciousness. The soul and its faculties, the great
y and the small entities, disappear, and we have to do
with internal events, which as sensations and mental
es translate physical events, or which, as ideas, move-
s, volition and desire, are translated into physical
ts. A great result is thus obtained; the state of con-
usness ceases to be an abstraction filling a vacuum. It

physiology descend at each instant into chemistry and physics to acknowledge its debt to them? Would any one say on that account that it is thus absorbed to their profit? Between the science of the phenomena of consciousness and physiology there is the same relation as between the latter and the physico-chemical sciences. If one objects that the passage from life to consciousness is inexplicable, it is only necessary to remark that the passage from the inorganic to the living is none the less so. The difficulty is then the same in the two cases, and it is illogical to maintain that a method that is legitimate in one case is illegitimate in the other.

III.

An incontestable truth, resulting from the very nature of the old psychology, is that it must remain a science of pure observation. The new psychology, on the contrary, has recourse, in a measure, to experiment. When psychological problems are put in the form we have indicated above; when the internal phenomenon, instead of being looked upon as a manifestation of an unknown substance, is considered in its natural connection with a physical phenomenon, it becomes possible to approach it by means of this accompanying physical phenomenon; for this latter is, in most cases, under the hand of the experimenter, and he is able to measure its intensity and variations, to place it in definite circumstances, to submit it to all the processes that constitute rigorous investigation. Psychology thus becomes, in the proper sense of the word, experimental. In fact, these processes are psycho-physical, but, the external and the internal being strictly combined, the object and final results are psychological. We will not attempt to give these here. The object of this book is to set them forth at length. Vague and general phrases convey no information. Suffice it to know that this method

which has now become classic.
old psychology employed in its process of investi-
only the method of agreement and the method of
ce. By this means it attained its principal object,
natural classification of the "manifestations of the
grouped under the names of the different faculties.

new psychology also employs these two methods,
adds to them a third: that of *concomitant variations.*
is not able, in studying heat, to drive it from body
ring it back again. It proceeds in an indirect way.
reases it, diminishes it, causes it to vary, and studies
variations in their visible and tangible effects. It is
y impossible to suppress and re-establish a form of
l activity for the purpose of studying its nature and
; but it is possible to vary it through the medium
physical condition. We capture the former through
tter. Thus we study not the phenomenon of con-
ness, but its variations. Or, more exactly, we study
cal variations indirectly by the aid of physical varia-
that can be studied directly. It matters not if the
s be complicated, provided it be rigorous. Know-
of natural facts is not easily obtained, and it is an

even to the greater number. So far there have only been attempts, fragmentary investigations; but these attempts mark the advance of psychology upon a new phase, the passage of the *descriptive* period into the *explicative*. It is no longer satisfied with being a natural history; it claims to be a natural science. This it is that explains the fact that the English and the German psychology, despite their community of end, has each its distinct characteristics; that one is systematic; the other technical; one rich in work as a whole; the other rich in work in detail. The best way to show this difference clearly is to indicate the place that each occupies in the evolution of psychical study.

Anterior to all science, the human spirit, as Wundt[1] has remarked, cannot collect the facts of experience without mingling them with its own speculations. The first result of this natural reflection is a system of general ideas, which are translated into language. When science begins its work, it finds these ideas already present. For example, in the domain of external experience, heat and light are concepts derived immediately from sensation. Positive physics reduces these two ideas to a more general concept: movement. But it has reached this result only by accepting at first, and provisionally, the indications of common sense. It is the same in the domain of internal experience. Soul, spirit, reason, intellection, are ideas which preceded all scientific study and made it possible. The mistake of the old psychology has been that it accepted these creations of the natural consciousness for definite truths. The soul, for example, instead of being considered simply as a logical subject, to which we attribute all the facts of internal experience as predicates, has become a real being, a substance, manifested in "faculties."

The study of the facts of consciousness in themselves, inependent of the general ideas that encumber language, arks the first attempts at a new psychology, and dates ack almost two centuries. In the midst of much doubt nd uncertainty, Locke, and those who have followed his tradition, go to an extreme, and reject all ideas already formed as popular prejudices. But as their psychology was still joined to metaphysics, no real progress was possible. The break has come only in our day.

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[1] *Grundzüge der Physiologischen Psychologie*, p. 8.

Yet the first representatives of the new psychology gave too large a part to verbal analysis and reasoning. They did not enter sufficiently into the facts themselves. In England, James Mill is the best example. Even Stuart Mill, so eminent as a logician, so profoundly versed in modern methods, though recognizing the utility of physiological study, concedes to it too little.

It is in contemporaries, whom it would be superfluous to name, that natural psychology attains complete self-consciousness. Bain may be regarded as their chief representative, in that his method, entirely descriptive, free from all hypothesis, evolutionistic or otherwise, rests in the order of positive facts and gives no room whatever to criticism. Questions are put in a natural concrete form. The internal event is never separated from its conditions and its physical effects. Physiology serves as guide. Pathological indications are used to profit. Each group of phenomena is studied minutely and the laws induced—the law of association and secondary laws—are given as the expression of constant and general relations.

Such are the essential traits of contemporary English psychology.[1] It is, in the largest and best sense, a descriptive study. In Germany, on the contrary, those who are working to construct an empirical psychology accord little place to description. To characterize their work we must employ a term which has been much abused in our day, but which is proper here, that is, *physiological psychology.* Almost all of them are physiologists, who, with their habits of mind and the methods peculiar to their science, have touched upon *some points* of psychology.

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[1] We include under this title all doctrines that present the same characteristics, to whatever country they belong.

We have seen above that the psychical life consists of a series of conscious states connected with physical states, and that these begin with sensation and end with action. We have also seen that in this uninterrupted series of psychophysical states those that are situated in the centre of the chain form a group most difficult of access by means of physical investigation. Ordinarily, German psychologists have neglected this last group, or have studied it only cursorily. But in the limited field to which they have restricted themselves, they have given psychology a new impulse. They have practised experiment. They have placed the psychical phenomenon in definite conditions and studied its variations.

As the whole experimental method reposes definitively in the principle of causation, physiological psychology has two systems of means at its disposal: to determine effects from their causes (for example, sensation from excitation); to determine causes from their effects (internal states from the actions that exhibit them). There is, moreover, need that one at least of the two terms of this indissoluble couple called the causal nexus be outside of ourselves, outside of consciousness; that there be a physical happening as such accessible to experiment. Without this condition, the experimental method cannot be employed. In the order of the phenomena that we call purely internal (the reproduction of ideas, their association, etc.), the cause and effect are in ourselves. Although we cannot doubt that the law of causality reigns there as elsewhere; although, in some cases, the cause can with certainty be determined; yet, as both causes and effects are in us, and give no external value, their physical concomitants being little known or inaccessible, all experimental research in what concerns them is necessarily impossible.

Indeed, some representatives of the German psychology have thought that, even where experiment fails, we are not driven to observation and description; that we may yet hope for more exact results. To reach them, they have recourse to calculation. They have treated some questions by a mathematical method. Assuming the principle that every internal event has magnitude, and that it has, in consequence, a mathematical character, they have tried to proceed in psychology as in certain branches of mathematical physics. They proceed on principles postulated as probable hypotheses; they deduce consequences by the aid of reasoning and calculation, and compare the results with those given in experience. For the success of this method two conditions are necessary: that the principal hypotheses be the product of induction and present indisputable signs of probability; and, following this, that the deductions that are drawn from them be constantly compared with reality and controlled by it. We will find in the course of this work some attempts of this kind. New and ingenious as they are, they certainly do not constitute the solid part of German psychology.

From what precedes we may learn the essential traits of the German psychology, and judge it in contrast with the English. It presents, as a general characteristic, a greater effort at precision; as special characteristics, the employ of experiment; quantitative determination (experiment supposing number and measure); a more limited field of study; a preference for monographs rather than extended works. Many of these investigations, we shall see, pertain to very modest questions, and it is probable that the partisans of the old psychology will find the work too great for results so small. But those who give allegiance to the methods of the positive sciences will not complain of this. They know how much effort the smallest questions require; how the solution of small questions leads on to the solution of great ones, and how barren of results it is to discuss great problems before the small ones have been solved.

IV.

If we have succeeded in showing the place German work occupies in the general evolution of modern psychology, it is almost superfluous to add that instead of excluding the results of the purely descriptive method, it supposes them. The two schools, descriptive and experimental, have the same object: the latter marks a growing tendency toward exactitude. But it is so far from being a complete psychology, that it offers us at present only attempts. The future alone will be able to fix its true value, and to say whether the scientific rigor to which it aspires can be altogether attained. Thanks to the employ of experiment and measure, it presents an original aspect: it is our business to put it in relief. Meanwhile it would be wrong to exaggerate the oppositions and differences in the results. It is only a branch of empirical, natural psychology, which, in its true state, demands, in large part, descriptive study.

Its great merit is that it has determined better than vague definitions can what is properly a physiological psychology. In consequence of a misconception that arises in many minds, this term is often understood as applicable strictly to the new psychology. This is not really true. When psychology, realizing a progress that it does not dream of now, succeeds in determining the conditions of all mental action, of whatever sort, as well of pure thought as of perception and movement, then psychology will be *entirely* physiological, and it will be well indeed. For the present there is an entire group of facts of consciousness whose study finds in the sciences of life only an indirect and unstable support. The processes of the old psychology —internal observation, analysis—find here their place; but the new school employs them only in support of physiological psychology, and to investigate two things: facts and their relations.

The field and place of physiological psychology is defined with sufficient clearness, as follows:

Its field, which ought to enlarge insensibly with progress in the physiology of the nervous system, embraces: reflex action and the instincts; detailed study of sensation with questions relative to time and space in the limits of experiment, movement, modes of expression and language; the conditions of the will and attention; the forms of the more complex feelings.

Its place is at the beginning of psychology. It studies what the old school called the inferior faculties of the soul; but in it alone the study of the highest manifestations finds a point of departure. It constitutes the most easily accessible and the simplest part of mental science.

This simplicity is, moreover, altogether relative. To be convinced of it one has only to read the books devoted to the whole or to some parts of the physiological psychology. In the presence of this constantly increasing mass of observations, experiments, measures, numerical determinations, of facts based upon the physical sciences, upon physiology, pathology, ethnology, of hypotheses and discussions varying without end in the service of new discoveries, and which denote a curiosity always on the alert on all points, always alarmed at forgetting or neglecting something—one finds himself in a new world, and he is not astonished that the disciples of the old school refuse to countenance a psychology that resembles theirs so little. Add the weariness of technical details, a dry mode of exposition, from which all literary adornment and oratorical effect are excluded, and one will understand how it is that some good spirits find themselves lamenting the psychology of the past, so simple, so convenient, so tractable, and expressed in such beautiful language.

And yet, if it is permitted to judge the future, this complexity is simple in comparison with that which will appear one day, when the domain of purely internal psychology will be entered upon. Let us suppose the physiological psychology, of which we have as yet only rough sketches, already complete; then only will it be possible to attempt this new conquest, and to penetrate into the internal mechanism of spirit by the aid of processes that to-day we do not suspect. What will this future science reveal? This no one can say, not even surmise; but from the difficulty of the work one can measure the enormity of the effort and see beforehand that this psychology will resemble the old as little as the physics of our day resembles that of Aristotle.

To confine ourselves to the present, the grandeur of the task is of a nature to call forth the boldest conjecture. If we cast a glance over the sciences of life, and consider the number of laborers, and the questions at which they are laboring, and the necessity for the untiring prosecution of details which alone gives true science, we will conclude that psychology should be in the same condition. The old school, in regard to the small number of facts that it demanded from the positive sciences, had set up the axiom "that the knowledge of results was sufficient." It was a rule of easy application but of little profit, for these results and the propositions that express them are only formulas without value for the man who does not know the facts by which they are supported.

This pretended axiom rejected, we may see the time approaching when psychology will demand the entire power of a man, when he will be psychologist alone, as he is

ist, chemist, physiologist alone. In every science
ourishes and is cultivated with enthusiasm, there is
ssary division of labor. Each important question
es a field by itself. Will not the profound study of
tions alone, for example, be sufficient for the most
mind? Empirical psychology, united to the other
l sciences by a tie of close connection, widens its
the constant work of analysis enlarges the mass of
s. Where the last century had twenty facts to master,
we twenty laws; and next will come laws of laws, that
generalization of more and more numerous facts. The
n brain has its limits, and is by necessity compelled to
ntrate itself upon a single study.[1]

fact, the number of those who are prepared for this
is very small. The majority of physiologists know
ittle psychology, and the majority of psychologists too
physiology. We live in a period of transition, and
ifficulties are sufficient to tax the greatest courage.
e is no one who has the progress of the new psychology
eart who does not feel, at all times, the lack of better
aration. It will be necessary, to undertake this inves-
tion with profit, to be versed in mathematics, physics,
iology, pathology, to have material to deal with, instru-
ts to use, and especially the aptitudes of experimental
ce. All this is wanting. In France especially, thanks
e prevalent ideas that our early education has given us,
the bad habits of mind that it has led us to form, the
d half of our life is spent in unlearning what we
ed in the first.

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would be interesting to ask what philosophy, as a general con-
n of the world, will be, when the special sciences, in consequence
ir growing complexity, become in their detail too large for the
, and when philosophers will confine themselves to the most gen-
d necessarily superficial results. It is a question which we submit
thought of the reader.

Psychology, in fact, has had the misfortune, hitherto, of being left in the hands of metaphysicians. A tradition has thus been formed that is difficult to break. In consequence of matured prejudice, men find it hard to admit that the psychologist should be a *naturalist* of a distinct kind. They persist in thinking of him as a "philosopher"; a title as inexact in this case as if it were applied to the biologist or the chemist.

As long as this antiquated opinion persists, the word psychology will have a very different meaning. This is the reproach that the old school casts perpetually at the new, that they know only the mechanism of mental life; and this is true. But only metaphysicians can ask more. If to know is to reveal an unknowable essence, then the new psychology has taught us nothing. But if to know is to study facts, to discover the conditions of their existence, and their relations, then it has done what it should do; and it is neither willing nor able to do anything else.

V.

It remains for us to indicate the object of this book. It is not to give a history of contemporary German psychology. In Germany, as everywhere, there is a spiritualistic psychology, which, under the different names of anthropology and the science of man, exhibits the classical traits of our current treatment of these questions.[1] In these works there are two constructive portions: the history and classification of positive truths, and their interpretation. The latter is not new and varies only in insignificant details. We will not treat of this psychology.

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[1] The principal representatives of this psychology are at present: Ulrici, *Gott und der Mensch*, 2 vols.; Hermann Fichte, *Anthropologie*; Harms, *Philosophie in ihrer Geschichte*, tome 1, *Psychologie*; Max Perty, very numerous works, in particular, an *Anthropologie*, 2 vols.; many articles in the *Zeitschrift für Philosophie und philosoph. Kritik*.

We have excluded purely metaphysical theories, idealistic and realistic. As large a part as they have taken in psychology, they have nothing to teach us. Here, as in all other departments of human knowledge, they deal only with principles and general characteristics; as for us, it is particulars that we seek.

We have excluded also the interesting "theories of knowledge," so numerous in Germany, due generally to vigorous and subtle spirits that bear the mark of Kant. They constitute a separate domain; that of general criticism. Their exposition would be a great task, and would require a volume alone.

These exclusions made, there remains a very limited field: it is the study of questions that are accessible at the same time to observation and consciousness, and to scientific investigation such as is practised in the laboratory; it is psychology considered as a natural science, stripped of all metaphysics and based upon the sciences of life. But our position is not as humble as it would seem, for these phenomena serve as base and point of departure for all the rest. Physiological psychology, as it seems to us, penetrates through unforeseen openings into the loftiest questions of human knowledge, and modest experimenting teaches more than volumes of speculation.

To estimate the spirit of contemporary German psychology well, it is necessary first of all to remember that the investigations that are to be presented are not the work of philosophers, or of speculative thinkers. They are due to scientists. German psychology presents us thus a particular and original character. While in England an uninterrupted tradition from Locke, through Berkeley, Hume, Hartley, James Mill, confronts our contemporaries, in Germany there is no tradition and no psychological school: all is new.

Kant's successors were metaphysicians, and, in our day, the critical school has succeeded them. Herbart alone, among his numerous disciples, can be called a psychologist. He sets out from *a priori* principles, gives little room to facts, much to reasoning and mathematics; but he had some new and good conceptions, and especially an influence. Transformed by Beneke and developed by others, his doctrine is becoming lost in rather vague speculations in anthropology and ethnology. But, at the same time, the true empirical psychology is growing, little by little, in obscurity, taking its chances on occasion in works or memoirs of physiology.

If a founder must be named, John Müller merits the title. In his books he assigns large part to psychological questions, and treats them fully. A disciple of Kant, he wished, in his way, to give a physiological basis to the theory of the subjective forms in intuition.

To each species of sensor nerve he attributed a specific energy, in virtue of which each organ reacts in a manner peculiar to it, whatever be the nature of the excitation which it receives. He transformed the Kantian doctrine of space in a physiological way, claiming that the retina had a native feeling of its extension. This hypothesis, taken up, modified, rejected, has given rise to a very lively debate that is still in progress, and touches upon the noblest problems of psychology.

After him, each order of sensation became the object of profound research. Men studied their qualitative and intensive differences. By penetrating deeper and deeper into the knowledge of anatomical and physiological mechanism, they were able to determine what, in sensation, is simple, immediately given, and what is added by the work of the mind (induction, deduction, the association of images). Where consciousness, of itself, sees only an irreducible fact, experiment shows many elements in combination. Going still further, Helmholtz shows, especially for sound, that a sensation called absolutely simple, free even from the psychological conditions of which we have just spoken, may be decomposed into elementary sensations that consciousness fails to disunite. His experiments have served as basis for the ingenious interpretations of Taine and Herbert Spencer.[1]

The same *savant*, preceded on this road by Dubois-Reymond, and followed later by Donders, Exner, Wundt, and many others, attempted to determine the duration of psychic acts. At first, sensations were studied; later, acts of a more abstract nature. This investigation continues, has thrown light on the mechanism and conditions of consciousness, and, as we may presume, will bring to light unexpected results.

Outside of biological science, Fechner has pursued a line of investigations aiming at the measurement of the intensity of sensations in their relation to the excitation that causes them. He has employed mathematics and physics. His generalizations have given rise to a lively controversy, and brought out verifications and counter-experiments. A considerable number of works have already appeared, which, in accordance with the title chosen by Fechner, are included under the name of psychophysics.

Such are the most general characteristics of the movement that has arisen in Germany during the last thirty years. Besides Müller, its principal promoters have been E. H. Weber, Volkmann, Dubois-Reymond, Fechner, Lotze, Wundt. Several of them have contributed to the progress of psychology without setting to themselves this object. One will not be astonished, then, that their work, as we are going to present it, has a fragmentary character, that they pursue different directions, and are engaged upon different subjects. They are scattered workmen; not at all resembling a school to the eye, that is to say, to the eye of those who obey a common discipline and pursue a common tradition. But there are traits common to all of them, and which distinguish them from every other group of psychologists: the experimental sciences as point of departure, a characteristic method, and a positive style of treatment.

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[1] Taine, *De l'Intelligence*, part 1, book iii.; Herbert Spencer, *Principles of Psychology*, vol. i., part 2, ch. i.

In most cases, it would have been impossible to proceed here as with the English psychology. We ought often for a monograph on a psychology to have substituted a monograph on a single question, and to have mentioned also works published elsewhere than in Germany. To our mind, this necessity marks progress. According as psychology, breaking its old metaphysical bonds, shall accustom itself to the method of the sciences that touch it most closely, will it carry less and less the imprint of one man or one race, and become the common work of all lands.

CHAPTER I.

BEGINNINGS: HERBART.[1]

I.

The first efforts toward a scientific psychology, in Germany, are due to Herbart. They constitute a transition from the pure speculation of Fichte and Hegel to the unmetaphysical psychology. This explains the fact that they are cited by such men as Helmholtz and Wundt, that they have had an avowed influence upon them, and that in other respects they have at present little more than an historical interest.

Herbart has given us his psychology in two works under the titles: *Psychology as a Science, founded, for the first time, upon Experience, Metaphysics, and Mathematics*, and *Handbook of Psychology.*[2] The latter is much more concise than the former, and is more difficult to read: it consists, for the most part, in a *résumé* of definitions and formulas.

The point that concerns us at first sight is that Herbart expects to found psychology on metaphysics. His point of departure lies "in being." The ontological principle upon which all rests is "the unity of the real."

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[1] Herbart was born at Oldenburg, May 4th, 1776; he studied under Fichte at Jena, was professor at Göttingen and at Königsberg. He died August 14th, 1841.

[2] *Psychologie als Wissenschaft, neu gegründet auf Erfahrung, Metaphysik, und Mathematik*, 1824–1825.—*Lehrbuch zur Psychologie*, 1815.—The edition that we use is "the complete works of Herbart," by Hartenstein.

Being, for Herbart, is absolutely simple, without plurality, without quantity; it is only a *quale*. He says somewhere: "Being is absolute position; its concept excludes all negation and all relation." And to pass from considerations of being in general to being in particular: "The soul," says he, "is a simple substance, not only without parts, but with no plurality whatever in its quality."[1] Its quality is unknown to us; but its activity, as that of everything else that is real, consists in *conserving* itself (*Selbsterhaltung*).

If everything that exists is absolutely simple by nature and by definition, whence, then, comes plurality? It arises from the determined relations that are established between one real and other reals. In consequence of these reciprocal relations, the reals are engaged in strife; and in consequence of this strife, the *Selbsterhaltung*, which essentially constitutes each of them, becomes a representation (*Vorstellung*). This is the hypothesis of Herbart. The representations (or, as contemporary psychology expresses it, the states of consciousness) are then "only the efforts of the soul to conserve itself." In other words, our sensations, our ideas, our recollections, all that constitutes our psychological life, exist for us only as an effect of our tendency to a self-conservation, which, through its relation to other reals, is determined and specific.

This metaphysical *début* is very dangerous, and nothing could be more just than the remark of Trendelenburg:[2] The concept of the real, with Herbart, rests simply in speculation, not in experience.

Although this be true, we will admit the hypothesis and examine more explicitly the genesis of the states of consciousness. We have now the matter of psychology, the phenomena that it studies; let us see how Herbart disposes of them. It is certain that, in spite of the marked taste for abstraction that he betrays in the misuse of metaphysics and mathematics, he shows a true appreciation of real fact, its evolution and its specific varieties. And one doubts this the less because the tendency which is with him in a state of germ is developed in his disciples; it is from the school of Herbart that later, as we shall see, ethnic psychology springs.

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[1] *Lehrbuch zur Psychologie*, part 3.

[2] *Historische Beiträge zur Philosophie*, vol. iii.

"The matter of psychology," says he, "is internal perception, intercourse with other men of all degrees of culture, the observations of the educator and the politician, the recitals of travelers, historians, poets and moralists, experiments on the insane, the sick, and on animals."[1] Besides, he remarks, "the man of the psychologist is the social and cultured man who represents the history of his race, arrived at its greatest height;" but as actual facts do not tell us what is primitive, it is necessary for this to have recourse to the savage and the child.[2]

To-day such views may seem common, they were not so in Germany sixty years ago; then, under the undisputed reign of metaphysics, they would have been original almost to paradox. I am inclined to think, however, that they were not entirely original with Herbart, but were suggested by the reading of Locke.

The taste for true fact in psychology has made Herbart the most determined enemy to the hypothesis of faculties in the soul. He takes occasion to combat it continually. Psychology has gone backward since Leibnitz and Locke, and this is due to the separation of the faculties by Wolff and Kant. The two first mentioned were wiser in letting this hypothesis alone, for "when to the natural conception of *what passes in us* we add the hypothesis of faculties *which we have*, psychology takes on the form of mythology." Empirical psychology, says he in another place, reveals to us three faculties: thought, feeling, desire; to these three faculties, as genera, it subordinates the others (memory, imagination, reason, etc.); then, under each species, it subordinates varieties (memory of places, words, etc.; reason theoretical and practical, etc.). But the real, the fact, is individual; it is not a genus, or a species. The general can be derived from the individual only by abstraction, according to rule; and how attempt this abstraction when the individual is imperfectly known, insecurely established?[1]

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[1] *Lehrbuch zur Psychologie*, Introduction.

[2] Ibid., part 2, ch. I.

To this respect for reality that we find in Herbart, although it very rarely touches upon individual facts, we must add a clear apprehension of the scientific method. He did not believe, as was then the fashion in Germany, that it was possible to construct psychology by means of pure deduction and logical argumentation. He proposed to apply to psychology "something that resembled the investigation of the natural sciences" (*welche der Naturforschung gleiche*). Sometimes he even seems to say that psychology can be constituted a science only on condition that a very large part be relegated to the unknown, and that one confine himself to phenomena. "Let experimental physics be ignorant of the forces of nature, yet it has two means of discovery, *experiment* and *calculation*. Psychology cannot experiment on man: it has no instruments for that; it ought all the more to employ calculation."

It is not certain, now in our day, that experiment is impossible in psychology, as Herbart maintained. The researches of Fechner and his successors have shown the contrary; an entire order of psychological facts has become accessible to experiment. But this is certain, that he had an exact idea of the conditions of the science; he knew that it could exist only with calculation, that is to say, with quantitative determination; or, indeed, with experiment, that is to say, with objective verification, and that in the absence of these conditions, the use of the word science is an usurpation and an abuse.

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[1] *Psych. als. Wiss.*, Introduction.

II.

Psychology has some analogy with physiology. "Even as the one constructs the body with fibres,[1] so the other constructs the mind with series of representations." Representations or facts of consciousness whose laws can be known—this is the matter of psychology. "But what we seek is not a mere register of facts; it is speculative knowledge, reduction to law." For example, "psychology asserts that the states of consciousness are associated in time and space, and it has never come to consider time and space as determinations merely that accompany this association; moreover, such a psychology is not vague, as the description commonly given would have us believe, but follows laws of strictly mathematical certainty." If we do not make use of calculation, we must renounce all psychology as knowledge. The internal sense, that pretended scientific instrument of the majority of psychologists, has not for Herbart "such easy prerogative and value in external experience, whatever imagined superiority men have been able to dream into it."

So far we know only one thing: the states of consciousness, according to the metaphysic of Herbart, are due to the effort that each real makes to conserve itself, when it enters into relation with other reals. But is there nothing here that resembles mathematical properties? Yes, for everything that is perceived within has properties that are general; that is, it exhibits itself as going and coming, oscillating and fluctuating, in short, as growing *stronger* and *weaker*.[1] Each term employed to express a representation conveys a concept of *magnitude*. We must admit then either that the facts of consciousness have no order, or that they have a mathematical character, and are capable of mathematical analysis.

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[1] We would say in our day: with anatomical elements.

Why has this analysis been for so long a time unattempted? Herbart has given many reasons. The principal reason is the difficulty of measurement. Psychological magnitudes are variable quantities which can only be estimated in an incomplete way. "But we can submit the variations of certain quantities, and these quantities themselves, as far as they are variable, to calculation, without determining them completely; upon this all infinitesimal analysis rests. As long as the calculus of infinitesimals was not invented, mathematics was too imperfect for this purpose." It is now possible to use it in constituting psychology as a science.

All our knowledge of internal facts is necessarily and characteristically incomplete; our mind, by a law peculiar to itself, must *complete* it (*Ergänzung*).[2] But in most cases the empirical data are so insufficient that this undertaking can be conducted only in a speculative way; and, for this, it is necessary, first of all, to demonstrate the existence of certain relations: that two quantities are functions of each other, that they are connected as a natural number and its logarithm, as a differential and its integral, etc.

In short, with Herbart, psychology consists entirely and alone in elaborating the facts of internal perception; in demonstrating the connection of the facts that perception ities, by means that perception can not indicate; and this according to general laws.[1]

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[1] *Psych. als Wiss.*, Einleitung.

[2] The word employed by English expositors of Herbart to translate *Ergänzung* is *elaboration*.—Tr.

Inasmuch as the states of consciousness, without exception, according to Herbart, are representations, and representations are *forces*, at least as far as they act in opposition to one another, he concludes that the task of psychology consists in establishing a static and dynamic of mind.[2]

We enter here into the heart of the psychology of Herbart. We must insist then upon its essential characteristic: the employment of mathematics.

Every simple representation has a determined *quality* which is invariable; the percept red, for example, can never become the percept blue. But every representation has also a *quantitative* value which is variable, namely, its degree of intensity, of force; or, more simply, its clearness.[3] A common fact will show that our representations are really forces that strive among themselves. Suppose, says Herbart,[4] that a man speaks an unknown tongue to you; you notice that each word, if it is not pronounced very plainly, leaves your memory immediately. The percepts produced in you by these different sounds have, then, the property of chasing each other out. Before we learn any language, every word produces on us the same effect. As a result of custom, the connection of the words has become easy; we feel no longer that each of them is an obstacle to the others; but this antagonism continues none the less: it is a general fact.

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[1] *Psych. als. Wiss.*, p. 220.

[2] It must be noted well that Herbart says expressly that the states of consciousness *are not* forces, but become so only in consequence of the relations established among them; just as the soul, as we have already said, becomes conscious only by accident. The subject representing is a simple substance properly called the soul. The representations are produced by external conditions, and are determined as to their quality as much by these conditions as by the nature of the soul itself. The soul is not, then, originally a representing (conscious) force; but becomes so from the existence of certain conditions. Further, the representations taken in themselves are not forces, but they become so in consequence of their reciprocal opposition.—(*Psychologie als Wissenschaft*, p. 31.)

[3] Drobisch, *Erste Grundlehren der Mathematischen Psychologie*, p. 15.

[4] *De attentionis mensura causisque primariis*, in the *Sämmtliche Werke*, vol. VII., p. 75, etc.

The principle that serves as support for all the rest is the antagonism of representations. Herbart, who proceeds as a mathematician, remarks that this hypothesis ought to be taken from the first in its most simple sense. "We do not deal with complex representations, designating objects by their determinations in space and time, but of very simple representations, such as red, blue, sour, sweet; in a word, of such as can be furnished by an immediate and instantaneous sensation." It is a metaphysical principle—the unity of the soul—that explains at once the antagonism of the representations and their association. As, in virtue of the principle of contradiction, two contraries cannot exist at the same time at the same place, so the contrary representations arrest each other reciprocally. Without this antagonism, all the representations would constitute only a single act of a single soul; and, in fact, they do constitute but a single act as far as no obstacles whatever introduce separation among them.

This antagonism between two states of consciousness does not belong to either of the two taken alone; it results from a relation. "If we hear a *c* alone, it does not oppose itself in our minds to a *d*. But if we hear c, *d*, at the same time, or if these two representations co-exist in our consciousness, then we perceive not only the sum *c*, *d*, but the antagonism between them."

Moreover, among the representations, the antagonism is very variable. "Let us take *blue;* it is less opposed to violet with its different shades than to red with its different shades; or, take *c*, it is more opposed to *d* than to c sharp, to *g* than to *c*. The arrest that is the consequence of the antagonism must vary with it."[1]

Let us admit, then, to place the problem in the most elementary terms, that there are in the mind only two representations, simple and contrary. Each has a degree of force or intensity of its own: we know that as the result of attention, or of some external cause, the intensity of a state of consciousness may become very great. The intensive magnitude of these two percepts can be represented by numbers. Let us call one of the representations A and the other B; designate by m and n their intensive magnitudes; then we can assert the relation $A : B = m : n$, although there is no unit or common measure to which we can refer A and B to determine their absolute intensive magnitudes. The representations being contrary, it is evident that the stronger will resist the more strongly. The resistance will be in the relation $\frac{m}{n}$. The more it resists, the less will it undergo change; consequently, the changes resulting from the opposition will be $= \frac{1}{m} : \frac{1}{n} = n : m$. The decrease in intensity which is brought about in this case is called by Herbart an arrest (*Hemmung*), and the object of the calculation is to determine; 1st. The sum of arrest (*Hemmungssumme*), that is to say, the total loss of intensity in the given case; 2d. The relation of arrest (*Hemmungsverhältniss*), that is to say, the way in which this total loss is apportioned to each of the two representations, in proportion to its intensity. To take an example, if we suppose two representations whose intensity is in the relation $= 3 : 2$, the arrest produced will be $= 2$, because, following Herbart, if it were greater than two, the more feeble representation would be destroyed, which is impossible. From the other side, it can not be less than two, because, in their internal shock, each representation tending to lose the least possible, all that is taken from the intensity of the one is added to the intensity of the other. The total sum of arrest being = 2, calculation shows that the loss for each is such that the stronger representation becomes = $\frac{11}{5}$, and the feebler $\frac{4}{5}$[1].

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[1] *Psychologie als Wissenschaft*, p. 40.

Such are the general principles on which the mathematical psychology rests. We may sum them up in the following propositions:

Representations become forces when they are in reciprocal opposition.

Representations, in consequence of this antagonism, lose a *quantum* of their intensity; this is called, in the language of Herbart, the *arrest* of the representation.

No representation can be destroyed; the arrest, partial or total, has no other effect than to diminish its tension, and cause it to pass from the state of real representation to the state of simple tendency (*Streben vorzustellen*); (it is this phenomenon that is called in ordinary language the passage of the conscious into the unconscious).

Two representations are in equilibrium when each of the two is sufficient to arrest the other. Each representation is then in a state of tendency; it is obscured (*Verdunkelung*).

When the representation emerges from this point of "obscurity," it gives rise to what Herbart calls a movement.

The calculation of this equilibrium and movement of representatives is the object of the static and mechanic of mind.

STATIC OF MIND.

It would be both outside our purpose and beyond our ability to give a complete exposition here. It will suffice to indicate the general characteristics of a question that has now, besides, only an historical interest.

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[1] Here is the calculation of Herbart:

We have: $(3 + 2) : \left\{ \frac{2}{3} \right\} = 2 : \left\{ \frac{\frac{4}{5}}{\frac{6}{5}} \right\}$.

Hence, the remainder of the stronger $= 3 - \frac{4}{5} = \frac{11}{5}$.

The remainder of the feebler $= 2 - \frac{6}{5} = \frac{4}{5}$.

The static of mind has for its object to study the conditions of equilibrium among representations, to submit their reciprocal arrest to calculation, and to indicate all the variations they present in combination.

Representations form different classes, such as colors, sounds, figures, etc., etc. Herbart calls each of these classes a *continuity*. According to him, representations belonging to the same continuity oppose one another; those that belong to different continuities do not. Thus color produces no arrest on a sound representation, etc.

Simultaneous representations are, by the very fact of the unity of the thinking subject in which they are found, capable of uniting, as far as the reciprocal arrest does not forbid it. But it is evident that this uniting must assume two very different forms, according as the two representations are of a different or of the same nature. In the first case, they can unite totally; in the second, they can unite as far as the arrest permits.

1st Case.—This is the most simple case. The representations belong to different continuities; "they can unite totally in such a way as to form a single force, which enters as such in the calculation." Herbart calls this a *complication* or an entire complex (union of a sound and a color).

The representations belong to the same kind; there results a partial union due to the opposition that exists between them. Herbart calls this a *Verschmelzung*, or fusion (union of red and blue).[1]

2d Case.—Here the representations oppose each other instead of uniting. Herbart reduces the problem to two principal forms:

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[1] Herbart distinguishes again complication and fusion as *complete* and *incomplete*; but we cannot give all the details.

1st. The two representations are in complete opposition, and are of equal intensity. Let two states of consciousness, A and B, have the same intensity=1, and oppose each other totally, "as red and yellow." In order that the arrest of A be zero, it would be necessary, as we have seen, that B disappear entirely. But each of the representations tends to conserve itself, and both strive with equal force. It results that each loses half of its original intensity.

2d. The two representations A and B are in complete opposition, and are of unequal intensity. Let the intensity of A $=a$, and that of B $=b$, in such a way that $a>b$. In this case, by the hypothesis of Herbart, the "sum of arrest would be $=b$, that is, equal to the intensity of the feebler representation; since, that there might be no further contradiction,[1] it would be sufficient that the feebler representation be overcome."

3d. Three representations, A, B, C, are in complete opposition, and their intensities a, b, c, are such that we can assert $a > b$, $b > c$. In this case, the sum of arrest is $=b+c$, that is, equal to the sum of the two feebler intensities, since, if their arrest were total, the representation A would maintain its entire intensity. Herbart determines by calculation how this sum of arrest $b+c$, is apportioned among the three representations. According to him, moreover, all cases are reducible to the three preceding, the conditions, equality of antagonism and difference of intensity, remaining the same.

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[1] We give here, under a general form, the calculation, a particular case of which Herbart has shown us above. The sum of arrest $=b$ is thus divided between two representations: A remains in consciousness with the intensity:

$$a-\frac{ab}{a+b} = \frac{a+b}{a^2+ab+b^2}.$$

B remains in consciousness with the following intensity:

$$b-\frac{ab}{a+b} = \frac{b^2}{a+b}.$$

In short, this equality of antagonism admitted, each representation undergoes an arrest *inversely proportional* to its intensity.

Herbart then examines two other cases:

1st. The intensities are supposed equal; but the degrees of antagonism are different. Then each representation undergoes an arrest directly proportional to the entire antagonism that exists between it and the other representations.

2d. The intensities are unequal and the oppositions unequal. For the solution of this case, very complicated calculations are necessary.[1]

Each representation, in consequence of the arrest that it undergoes, can be chased from consciousness. But this exclusion has degrees, and, in this passage from the state of real representation to the state of simple tendency, it has an important statical point that Herbart calls the *threshold of consciousness*: "By threshold of consciousness (*Schwelle des Bewusstseins*), I mean those limits that a representation seems to overleap in passing from a state of complete arrest to a state of real representation." Calculation can determine the conditions under which a representation attains an infinitely small degree, while still a representation; under which, consequently, it touches this limit.[2] It is "below the threshold," when it has not the force to fulfill these conditions; and "above the threshold" when it has attained a degree of real representation. In other words, the threshold of consciousness is the limit at which the intensity of a representation can be considered as $=0$. The "worth of the threshold" is the value a representation must have to retreat just to the threshold of consciousness. For example, if $a = 1$ and $b = 1$; c, at the exact moment that it arrives at the threshold of consciousness, will have a value $= \sqrt{\frac{1}{2}}$ or 0.707.

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[1] Let the intensities be a, b, c; and the antagonism between a and b $= m$; between a and $c = p$; between b and $c = n$; the arrests will be: $\frac{m+p}{a}$, $\frac{m+n}{b}$, $\frac{n+p}{c}$.

[2] *Psychologie als Wissenschaft*, p. 43, &c.

Below the threshold of consciousness, all perception belongs to the category of insensible perception of Liebnitz. For Herbart, the simple representations are not infinitely small, but the *complexes* resulting from their fusion overleap the threshold of consciousness. "They are not," says Drobisch, "differentials, but the integral of differentials. Mathematical psychology can no more start with the study of the insensible perceptions from which the simple perceptions result, than physical mechanics with a theory of molecular attraction. The concept then of simple representation is as valid as that of the material point or of the molecule; it is a scientific abstraction, but it has its validity none the less."[1]

MECHANIC OF MIND.

This section of psychology studies representations in a state of movement. If we consider the state of each representation as being produced in successive stages, there is room to enquire with what *quickness*, constant or variable, the obscurity will be produced, and in what time it will be finished.

"The analogies between the mechanic of mind and that of body, moreover, must not make us forgetful of their points of difference. We do not deal here with angles, sines, cosines, etc., etc., nor with infinite extension; but every movement of the representations is confined between two fixed points: their state of complete arrest, their state of complete liberty. Instead of the attraction that draws bodies downward, we have here the natural and constant effort of all the representations to revert to their state of complete liberty (absence of arrest)."

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[1] *Erste Grundlehren*, &c., p. 16.

If we set out with a state of equilibrium, or, as is more really the point of view of psychological experiment, with that state of arrest in which the representations are, we see that, as new forces intervene, the equilibrium is broken; the sum of arrest decreases and a movement of the representations begins. The mechanic proposes to apply calculation to the following questions: The diminution of the sum of arrest; the quickness of movement for each representation; the *quantum* of time during which it is executed; the mediate or immediate awaking of representations.

We cannot enter here into an exposition. We will only attempt to show how, by the aid of the "law of reproduction," Herbart believes he can explain the formation of general ideas, and, in particular, the notion of space.

In consequence of this strife for existence among them, each representation occupies the consciousness only a limited time, and is changed into a simple tendency. Herbart does not give us a very clear idea of the nature of this tendency; we can represent it, however, as a state of equilibrium; equal and contrary forces check each other mutually. But when any circumstance occasions a diminution of arrest, the tendency becomes again a real representation; it attains first the "threshold of consciousness," the visible horizon, then mounts above the horizon (*Steigen*). This ascending movement of a representation excites that of analogous states, and thus the general idea is produced in consciousness. It is due, then, not to a special power that the soul exercises over the simple perceptions, but to a mutual reaction of analogous perceptions; the differences are obscured in the mass of perceptions, and there remains only what they have in common.

If we consider the notion of space, we will find that it arises from a succession of sensations. Our states of consciousness can be associated in different ways, whether it be for the production of combinations or the formation of simple successions. The successions themselves are of different kinds; but there is one alone that suggests to us the notion of space; it is the succession *that can be reversed*, that is, whose different terms read indifferently from A to Z, or from Z to A. Movement (of an arm, a limb), considered as a real fact, plays for Herbart only a secondary role in the acquisition of our notion of space; it is the occasion of this idea only as far as it produces in consciousness a series of states that can be reversed. "During the progressive movement," says Herbart, "the first representations fall (below the threshold) successively, and are fused gradually with those that follow. But upon the least return backward, these earlier representations come back *en masse*, are raised (above the threshold) by means of those which are there added, and which resemble them. It thus happens that each representation assigns its place to all the others, since it must place itself beside and among them."[1]

The notion of space arises then for Herbart from an association among states of consciousness. Every other moment (feeling of muscular activity, resistance) is neglected by him; he takes account only of states of consciousness and their relations. This has given occasion to Lotze to object to this theory, that certain series (for example, the musical scale) can be read indifferently, from up down or from down up, without giving the least idea of space; and to other critics,[2] who have maintained that this derivation of space itself previously implied the idea of space.

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[1] *Psychologie als Wissenschaft*, pp. 119, 120.

[2] *Zeitschrift für Philosophie* (1866, vol. 1, 2).

III.

We are not concerned with the study of the psychology of Herbart in all its details; what precedes contains the essentials; there remain only two points to detain us; his theories of sensation and the Ego.

To Herbart, all psychological facts, without exception, are representations. The phenomena called feelings, affections, emotions, desires, passions, etc., do not constitute a separate species opposed to ideas. The phenomena of feeling, according to him, are not of an irreducible nature; they do not present essentially distinct characteristics; they should not form a separate group; they do not represent a second mode of psychic life. On the other hand, the feelings are not representations. What are they then? They are simply relations. The particular states of the soul that everybody calls feelings (with their varieties) are the *relations between representations*. This doctrine is found *en germe* in Aristotle. It was early noticed that a group of feelings—the æsthetic feelings caused by sound—depended upon intervals, that is, upon relations between perceptions. Herbart has generalized this theory and extended it to all the feelings.

"Feeling (*Gefühl*) arises when one representation remains in consciousness in consequence of an equilibrium among the forces that arrest it and those which tend to raise it." This definition must be explained. When one representation overleaps the threshold of consciousness and is expanded, a state is produced, which, in the common language of psychology, is called an intellectual act. If, on the contrary, the sum of arrest is increased, the representation is driven below the threshold; the intellectual act ceases. But another case may arise: suppose that one representation lies in consciousness; if two other representations of equal and contrary force tend, one to retire it, the other to increase it, a state of equilibrium is produced. This state, resulting, as it seems, from a relation among the representations, produces a feeling. Thus, says Lindner, one of the latest disciples of Herbart,[1] if we take a feeling such as *affliction* caused by the loss of a friend, the idea of that friend is caught "as in a vice" between two ideas: that of his death, tending to produce an arrest, that of his benefits, tending to a contrary effect.

Herbart praises highly the division (from Kant) of the emotions into two classes: 1st. The exciting emotions (*rüstige*), such as joy and anger; 2d. The depressing (*schmelzende*), as fear and sadness. He defines the first as "the emotions that bring into consciousness a *quantum* of real representation greater than it can contain;" and the second, as "the emotions that drive from the consciousness a *quantum* of representation greater than that which ought, from the nature of these representations, to be there."

In regard to the desires (*Begehren*)—of which Herbart forms a group including the propensities, the passions, and the will as desire reaching after a moral end—he defines them as follows: "Desire is the predominance of a representation that strives against obstacles, and thereby in this sense determines the other representations."[2]

Every passion has for its foundation a dominant representation; when the representation of the object desired does not rule, there is no passion. The strength of passion, its characteristic irresistibleness of tendency, consists in the continued effort of the dominant representation—or, rather, of the group of representations which pertain to the object of the passion—against the continued arrest that it undergoes in consciousness. Passion arises from a mass of immoderately intense but connected representations, which stand in opposition to the regular combinations of representations. In metaphor, it is the antagonism of passion and reason; but, as we see, these are not two faculties, two entities, opposed to each other. "Passions are tendencies in the direction of desire, which have their foundation in the interaction of representations. They are tendencies, and not acts; and this explains the fact that there are not only passions but passionate natures. The absence of civilization and education favors the development of such natures, because the more isolated ideas remain, the more their union is reduced to rule and order, the more powerfully will each act for itself alone, and awake only ideas that can enter into helpful combination with itself."

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[1] Lindner, *Lehrbuch der empirischen Psychologie*, p. 117.

[2] We do not give here the detailed classification of the emotions according to Herbart; that would take us too far. See *Lehrbuch zur Psychologie*, 2d part, chap. 1 to 4.

Thus everywhere in the psychology of Herbart we find representations only. For him this fact alone explains all the details of the mental life. It explains it as unity. The Ego, or, if one prefer the other expression, the consciousness, is not, in fact, for Herbart, a thing apart. While earlier psychologists maintained that, for a representation to be possible, it was only necessary that consciousness occupy itself with it, with Herbart, and his school, on the contrary, consciousness is only the sum of actual representations. In short, it is an effect and not a cause, a result and not an original fact. Just as a thing or an object is the point where different series of images meet, so the I is the point where all the series of our representations meet; and the representation of the I, or the individual consciousness, is produced only as we differentiate this point from the particular series that intersect there.

IV.

We cannot attempt here an extended criticism of the psychology of Herbart. Such a study would necessitate a profound study of details, and could be made only by one versed equally in psychology and mathematics. We will attempt only to show wherein the originality of his effort consists, what new conception he introduced into psychology, and the nature of the movement that has arisen from it.

At the first glance, his originality is striking. The method of Herbart is neither the analytic method of Locke, Condillac, and the ideological school that has followed them; nor the descriptive method of the Scottish school; nor the physiological method, seen dimly by Hartley, and developed in our day. Conformably to its name, it rests psychology on a threefold basis; according little to experience, more to metaphysics, and much to mathematics. His method is, then, above all, mathematical. It is surprising enough that a disciple of Kant should have been the first to inaugurate it. Kant, indeed, ventured to predict "that psychology could never be raised to the rank of an exact natural science"; and he gave two principal reasons for this assertion:

1st. Mathematics is not applicable to internal phenomena, because these phenomena are referred to one condition only, time; or, to give his words, "because the internal intuition in which these phenomena must be construed has only one dimension, time."

2d. Internal phenomena are not accessible to experiment, that is, to observation made in circumstances that are determined, that are variable at will, and that are subject to the employment of measure.

To the first of the observations of Kant,[1] i. e., that in order to present internal facts in mathematical form, they must have at least two dimensions, it has been answered that this is actually the case, and the conditions insisted upon are realized. Our sensations, perceptions, feelings, are subject not only to the condition of time, but to variations of *intensity*. They are intensive magnitudes forming a series in time.

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[1] For this discussion, see, in particular, Wundt, *Grundzüge der physiologischen Psychologie*, pp. 5, 6.

As to the second point, although Herbart seems never to have conceived the possibility of experiment, it is sufficient to recall the work done later in psychophysics by Fechner, Volkmann, Helmholtz, Wundt, Delbœuf, etc., which is to be treated at length in this book. Doubtless, our states of consciousness are undetermined magnitudes. But is it impossible to determine them, that is, to submit them to measure? The essential condition of measure is that there be a fixed relation between the measure and that which is measured. Such a relation is that of effect and cause. In the physical sciences, we measure variations in cause by variations in effect. In psychophysics, it is the contrary; the variations of cause measure the variations of effect. The measurement of time offers a very old example of this process. Let us measure the course of our internal states by the aid of their external cause—the movement of objects in nature—movement that itself occasions the succession of our states of consciousness. It is an analogous process, it seems to us, that psycho-physicists pursue in employing the intensity of excitation (cause) to measure the intensity of sensation (effect). Perhaps, indeed, it would be possible to proceed here exactly as in the physical sciences; to measure, as they do, the cause by the effect, that is, the phenomenon of consciousness by the external action that it produces, i. e., by movement. But this method has been hitherto little followed because it presents great difficulties. To conclude, it is evident that the assertion of Kant cannot be accepted without examination by any one who has any acquaintance with the studies in psychophysics which have been published in the last fifteen years.

Yet—and this brings us back to Herbart—experiment has been applied to one group only of the states of consciousness, to the perceptions. It *would appear* applicable also to another group, to the states of consciousness connected with motion, *i. e.*, to the reactions that follow perception. But these two groups are far from including the totality of internal phenomena. Memory, abstract notions, the logical processes, etc., appear to be outside of every experimental process. We might, indeed, calculate their rapidity, their duration; but their intensive variations remain undetermined. Consequently, the only possible attempt to proceed scientifically here consists in the employ of hypothesis and calculation. This is precisely what Herbart attempted. He wished to apply throughout the entire domain of psychology the method pursued in the other sciences, such as mathematical physics. This method consists in setting out with hypotheses that are probable and based upon experience, in applying calculation to them, and finally, in verifying by experiment the value of the theoretical results. Has Herbart followed it?

His point of departure is certainly hypothetical. We will not speak of the threefold supposition that he urges upon us from the first (unity of being, tendency to conservation, fact of consciousness as its result): it is perhaps a necessity inherent in all psychology, even the experimental, to set out with some metaphysical hypothesis. The true hypothesis that serves as basis for his psychology is that states of consciousness are forces that strive among themselves. This hypothesis, if it is not the best nor the only possible one, rests at least on positive facts. But Herbart adds to it a series of others that seem entirely arbitrary. We have already noted many by the way, and it would be easy to point out others. Thus he admits that the representations have residues, by means of which they form a combination (*Verschmelzung*); but he adds that between each representation and the residues, there is a reciprocal action that is directly proportional to the product of the combined residues, inversely proportional to the intensity of the representation." This hypothesis rests on no fact of experience and on no mathematical necessity. Again, in order to determine the absolute intensity of a representation, he posits the following hypothesis, which is entirely arbitrary and improbable: if two representations, *a* and *b*, are in complete antagonism, and there arise a third, *c*, less antagonistic, the antagonism between *a* and *b* ceases immediately, and both fall on c, almost, says a critic of Herbart, as two fighters might fall upon an innocent man. It is certain, as Wundt has remarked, that, if reciprocal arrest belongs essentially to antagonistic representations, the intervention of *c* ought simply to modify that antagonism, not to suppress it; just as the attraction between two bodies is modified, but not suppressed, by the intervention of a third. The common defect in the hypotheses of Herbart, is that they are rarely based upon experience and supported by previous induction. As for experimental verification of results, it is completely wanting. Herbart does not appear to have foreseen the work in psychophysics of which we have spoken. And, moreover, this verification could only have been done by physicists and physiologists, and Herbart was a pure metaphysician with mathematical training.

His conception of psychology is that of a mechanic of mind. He tried to pass from vague description of psychic phenomena to precise knowledge of the elementary states that produce them. The phrase cited above: "Psychology constructs the mind with representations as physiology constructs the body with fibres," shows that he made toward a revolution analogous to that of Bichat in anatomy. Bichat substituted a much more philosophic study of the organs for pure and simple description: the study of tissues (later, anatomical elements). If Herbart had succeeded, he would have created a general anatomy of the soul. But the very form of his attempt doomed him to failure; for if ever the reduction of the states of consciousness to a mechanic become possible, it will not be by means as simple as he imagined. Admitting, as is possible, though there is nothing to prove it, that calculus can one day be applied to psychology as to physics, it is certain that this last phase of the science can be attained only when, by successive reductions, psychology has been previously relegated to biology, biology to sciences less and less complex, and finally to mechanics. Thus, in our day, it is not to an abstract mechanic, that is, to abstract relations between abstract forces, that psychology has recourse; it is the nervous mechanism alone that concerns it, and this is a sufficiently heavy task. It is better understood now than fifty years ago, that the transition from psychology to mechanics can not be made at once.

The judgment of one of the latest disciples of Herbart, Volkmann von Volkmar, will serve us in conclusion. Very favorable, as is natural, to the mathematical psychology, it has, on the other hand, the advantage of fixing its true meaning, and of determining the exact position that we must assign him in the school.

"Mathematical psychology," says he,[1] "is not, as Fortlage would have it, 'an ingenious diversion in imaginary magnitudes.'" It consists in submitting to systematic exposition all the quantitative determinations that are necessarily met in the psychological functions. The ideas of action and reaction, the intensity of representations, movement in the different states of consciousness, are met, under one name or another, in all systems of psychology, and even in common language. It is certain that these facts have a more or less quantitative character. The mathematical exposition differs then from the common exposition, only that it seeks to state with exactitude and precision what common usage leaves undetermined. It is unjust to confound the attempts of the school of Herbart with the pretended mathematical philosophy that consists only in an empty play of formulas, deductions, and arbitrary calculations. *Mathematical psychology never proposes to be the whole of psychology.* It refrains from all investigation of the nature of the soul, its relation to body, the origin of representations; it does not apply calculation to simple states. Its only pretension—and it is a just one—is to afford a method of finding the exact formula of the general laws that rule the reciprocal relations of representations, and of attempting a mechanic of the intensive states of the spiritual life.

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[1] *Lehrbuch d. Psychologie*, u. s. w., 2 vols., 1875–6, I, p. 476, etc.

"It is objected that it is impossible to find a measure for psychic magnitudes: whence it is concluded that mathematical psychology is barren. The objection would be just, if the effort were made to apply calculation to concrete states; but it is made only to determine relations, and never to measure by a fixed standard the states of consciousness themselves.

"It is added that the relations with which psychology deals are rather qualitative than quantitative and these latter can not be isolated. A remark that is true in many respects, but is of value only against a system that tends to absorb the whole of psychology in mathematics."

The author whom we have quoted understands that till now attempts have taken as point of departure hypotheses too simple and too systematic, that they have been too dependent on the problems of pure mathematics, that certain difficult questions have been treated too lightly; but he maintains that the method of Herbart leads up to problems that are inaccessible by any other method, that heretofore this method has been developed too little, and its history has been too short for a fair judgment.

CHAPTER II.

SCHOOL OF HERBART AND THE ETHNOGRAPHIC PSYCHOLOGY.

I.

WAS the effort of Herbart without precedent? Following Rosenkranz, the first systematic application of mathematics to psychology was made by a physician of Vienna, Niesley, who has been completely forgotten.[1] Whatever erudition may bring to light on this point, the effort of Herbart belongs peculiarly to him, and he alone has founded a school. As this book is not a history of German psychology, it is not in point to enumerate his disciples. It will suffice to show, at some length, that he originated a great movement.

Drobisch (Moritz-Wilhelm), who is still professor in the University of Leipzig, may be considered the oldest and principal representative of the school. His psychology, contained in two works, especially in the *Erste Grundlehren der Mathematischen Psychologie* (1850), is characterized by remarkable clearness. "Mathematical psychology," says he (work mentioned, p. 7), "is confined to the phenomena of consciousness, and seeks to establish mathematical relations among them. To do this it must build upon hypothetical concepts that are not given under color of fact; but it proceeds otherwise than mechanics, which supposes impenetrable material points, forces in action, and a law of inertia. Until it has succeeded in establishing mathematical relations among psychic phenomena, it leaves to metaphysical speculation the task of interpreting these mathematical facts in a sense that is materialistic, idealistic, intermediate, or any other." Further than this, Drobisch is considered to have hastened the return to the philosophy of Kant, a return in which all the German schools have more recently joined.[1] Further, we will name Cornelius, who is specially skilled in the physical sciences, but who, besides his studies in electricity and molecular physics, has published a *Theorie des Sehens und Raumlichen Vorstellens* (1861); Nahlowsky, who has studied feeling in his *Gefühlsleben* (1862); C. A. Thilo, who is the historian of the school; Rob. Zimmerman, at present professor in the University of Vienna, who is its æsthetician. The influence of Herbart lives in some of the physiologists, as

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[1] On this point, see Volkmann v. Volkmar, work already quoted, vol. I., p. 480. He cites a passage from Wolff, little known, which shows that this disciple of Leibnitz had conceived the possibility of a psychometry. In his *Psychologia empirica*, § 522, after some demonstrations, he adds: *Theoremata haec ad psychometriam pertinent, quae mentis humanae cognitionem mathematicam tradit, et adhùc in desideratis est . . . Haec non alio fine a me adducuntur quam ut intelligatur dari etiam mentis humanae cognitionem mathematicam atque hinc psychometriam esse possibilem, atque appareat animam quoque in eis quae ad quantitatem spectant leges mathematicas sequi, veritatibus mathematicis, h. e. arithmeticis et geometricis in mente humana non minus quam in mundo materiali permixtis.*

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[1] Vaihinger, *Dühring, Hartmann u. Lange*, p. 234. It is curious to notice that, in 1850, that is before most of the contemporary English works, Drobisch explained clearly the general nature of the law of association in psychology. "Psychology shows that not only memory and imagination, but judgment, reasoning, conscience itself, and in general all higher activity and all development of mind rest upon the association and reproduction of states of consciousness: that this explains also the different variations of feeling, emotion, desire, passion, and rational will. But these explications are supported by generalities that have always an indeterminate character. This arises from their lack of quantitative determination (Work cited, p. 3).

John Müller, and in one of Germany's greatest students of insanity, Griesinger, who has even borrowed from Herbart his definition of madness.[1] The best idea, moreover, of the influence Herbart has exerted on philosophy in general can be obtained by a perusal of the *Review of Exact Philosophy*,[2] founded in 1860 by Allihn and Ziller, upon which most of the Herbartians labored. But we propose here another end, *i. e.*, to show that this school has produced an *ensemble* of research which, in direct opposition to the simple and exact character of mathematical psychology, presents a character singularly vague and complex. (It is the ethnographic psychology, represented by three disciples of Herbart: Waitz, Lazarus, Steinthal.)

At first sight it seems strange enough that so concrete a form of psychology should attach itself to the school of Herbart; but, in fact, the disciples have only developed some of their master's views. This point deserves attention, for one would hardly suppose that the founder of the mathematical psychology would have attached great importance to such investigations. He maintains, however, that psychology remains incomplete as long as it considers man only as an isolated individual.[3] He was convinced that society was a living and organic whole, ruled by psychological laws that are peculiar to it. He has written a static and mechanic of the state, as he made a static and mechanic of ideas. Some of his disciples have developed what he only indicated: thence has arisen a kind of work that psychology did not know before and with which we will now be occupied.

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[1] Griesinger, *Traité des maladies mentales*, French trans., p. 66.

[2] *Zeitschrift für die exacte Philosophie in Sinne des neueren Realismus.* Among contemporaries we will mention the author of the *History of Materialism*, A. Lange, who has himself published *Die Grundlegung der mathematischen Psychologie.* Duisburg, 1865.

[3] *Lehrbuch der Psychologie*, 2d ed., p. 240.—For details on this point, see Herbart: *Allgemeine praktische Philosophie*, ch. 12, and the two essays: *Bruchstücke zu einer Statik u. Mechanik des Staates; Ueber einige Beziehungen zwischen Psychologie u. Staatswissenschaft.*

II.

"Do you want to understand the Greeks and Romans," said a philosopher of the eighteenth century, "study the English and French of to-day. The men described by Tacitus and Polybius resemble the inhabitants of the world that surrounds us."[1] In our day we think differently: we believe that this abstract study, amounting to some general characteristics, gives a knowledge of man but not of men: we believe that all who share our common humanity were not cast in a common mould, and we are curious about the smallest of these differences. Hence a new conception in psychology.

As long as naturalists confined themselves to a pure description of races and of species considered as permanent; as long as historians, indifferent to the variations of the human soul in the lapse of ages, spread upon all their recitals the same uniform and monotonous varnish; an abstract psychology, like that of Spinoza and Condillac, seemed the only psychology possible. Nothing else was thought of, and when a very refined and subtle spirit was subjected to minute analysis, it was said of this psychology: It has given us to know man.

But when the idea of evolution was introduced into the sciences of life and into historical study, stirring and renewing the whole, psychology felt the impulse. The question was raised: is this abstract study of man sufficient? Does it give more than broad traits and general conditions; to be simple and exact, does it not need completion? The lower forms of humanity have exhibited particular modes of feeling and action, and the history of civilized peoples has shown variations in sentiment, in social ideals, in moral or religious conceptions, and in the languages that express them.

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[1] Hume, *Essays*, VIII.

Psychology has profited by it. It occupies, in fact, in the structure of human knowledge a very exact place between biology below and history above. For if it is clear that sensation, feeling, and thought exist only where there are brain, nerves, and organism, it is also clear that social, moral, religious facts, history entire, is only an effect of which the human soul is the cause. Thus psychology shoots its roots into the sciences of life and blossoms in the historical sciences. Whatever comes to light in these two groups of sciences concerns psychology and often modifies it profoundly.

Of the two, biology has done more, and we may well believe that what it has given is little compared with what it has in reserve. At the first, it took hold upon the very sources of the psychic life: it contains the causes. Complex as it is, it is much less so than history. It has, above all, the advantage of a more precise and rigorous method, in that it employs direct observation and experiment.

The deposits of history are less numerous and more vague in character. The study of language, religion and custom has led, however, to important results; and if psychology is to be no longer a tissue of abstractions, but is to force its way more and more into reality, it must apply itself resolutely to solve the problems of linguistics, morals, and æsthetics, which are important parts of itself. If mathematics owes its progress largely to the necessity of leaving the domain of pure abstraction in order to explain the complex phenomena of astronomy, mechanics, and physics, is it not natural to suppose that this abstract psychology which has been taken for a long time for psychology entire, will find profit in the same, by applying itself to the study of the varied facts of human nature in history, custom, religion, literature, and language? The mental world has been so imperfectly explored only because the science that attempts it has been shut up in itself, has been entirely speculative, and has despised or neglected the spontaneous and concrete manifestations of spirit.

We must be grateful, therefore, to all in Germany who have attempted to contribute to the difficult work that has been called ethnic psychology.

An early difficulty is to determine precisely what place the representatives of the *Völkerpsychologie* occupy in the present movement. Man is studied in so many ways by anthropologists and historians, by the literary critic and the linguist, that in this body of efforts, which are often contradictory, however they tend to the same end, one finds it difficult to set himself right. Without attempting here anything like a classification, we are able to distinguish three principal currents.

The most considerable of these, is that of the doctrine of the transformists. By its very general character and its preoccupation with the problem of origin, this doctrine has a character as much philosophic as psychologic, although it has brought some excellent ideas into psychology; as that of evolution and hereditary permanence.

The anthropologists form the second group. They are especially given to the study of physical man, confining themselves to vague generalities as to the psychological varieties of the human race, its customs, sentiments, ideas.

Some others, on the contrary, have given themselves entirely to these latter manifestations. Part, as Lubbock, Tylor, MacLennan, Bachoffen, Herbert Spencer (in his *Descriptive Sociology*), have investigated the natural history of custom; others have studied language and religious beliefs; and others, finally, as M. Taine, have applied the critical psychology to the exposition of literature and the fine arts.

It is to this third group that the two men belong of whom we wish to speak: Theodore Waitz and Lazarus. While Haeckel, Fechner, Gerland, Peschel, develop, discuss, or transform the ideas of Darwin;[1] while Vogt, Virchow, Schaffhausen, represent pure anthropology; others have attempted the psychological study of the races of man, and, though their work has been modest, it is worth the trouble of describing.

Although not known to us, Theodore Waitz has a distinguished place in contemporary German psychology, and is often quoted in his own country. Born at Gotha, March 17th, 1821, he studied under Drobisch, in the University of Leipzig. At the age of twenty years, he travelled in France and Italy, for the purpose of collecting manuscripts, and of preparing a critical edition of the *Organon* of Aristotle, which appeared in 1844. He located, on his return, as *privat-docent* in the University of Marburg, and never left that place. There he became a very intimate friend of Ludwig, now Professor in the University of Vienna, and one of the greatest physiologists of Germany. The two friends worked hard, instructing each other mutually: Waitz gave Ludwig lessons in mathematics, and Ludwig taught Waitz physiology and anatomy. At that time Waitz published his *Handbook of Psychology*

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[1] Fechner, in his work *Einige Ideen zur Schopfungs- u. Entwickelungsgeschichte der Organismus* (Leipzig, 1873), undertakes especially to explain the relation of the organic to the inorganic. According to him, the latter results from the former; experience shows us this every day in the decomposition of organic bodies, which are transformed into inorganic elements. The *processus* in virtue of which nature is developed in its infinite variety, results from the contrary action of two principles: stability and correlative differentiation. Gerland (*Anthropologische Beiträge*, Berlin, 1875), maintains that evolution can be explained by a purely atomico-mechanical process, in which a "psychic principle," recalling the monads of Leibnitz and Herbart, controls. Peschel has published a *Völkerkunde* (Leipzig, 1874). Haeckel's works are well known.

as a Natural Science,[1] a book whose style and mode of expression are remarkably clear and precise. And what is not less worthy of our notice, it has a certain physiological coloring that is very rare in the school of Herbart, especially at that period. Waitz reports experiments, discusses and interprets minor details in optics and acoustics: the whole seems little to-day; but to be impartial we must carry ourselves back forty years. Besides, we must not conclude that he was unfaithful to his master, and proposed to exclude all metaphysics from psychology;[2] he proposed, on the contrary, through the mediation of Herbart, to reconcile the two parties then existing: one, that saw in psychic phenomena only forms of body (the materialism of Feuerbach), the other, that referred all to spirit (the idealism of Hegel).

Ten years after the publication of this treatise on psychology, Waitz prepared the first volume of his great work, *Anthropologie der Naturvölker*.[3] He left it unfinished, and, although now superseded, it is none the less a monument.

How did Waitz pass from abstract to ethnographic psychology? Even in the *Handbook* he was embarrassed by frequent reappearances of the *Naturmensch*, and in particular by the way in which the external world was represented to him; he seemed to have glimpses of the importance of these concrete researches; but we know by the testimony of his pupil, George Gerland, that he was drawn on by the study of religions. Waitz "desired earnestly to unite the two poles of mental life: natural science and religious faith." He proposed to write a philosophy of religion. With this work in view, he studied anthropology, to attain a solid foundation of fact, just as he had studied anatomy before writing his *Psychologie.* He found that this *Anthropologie der Naturvölker*, conceived at first as preparatory work, served another end, *i. e.*, the natural history of uncivilized peoples. We must indicate precisely the peculiar character of this work.

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[1] *Lehrbuch der Psychologie als Naturwissenschaft*, 1849, Brunswick. This book is a more matured form of the *Grundlegung der Psychologie*, published in 1846 (Hamburg and Gotha).

[2] His book contains four principal divisions: 1st, Nature of the soul and the general laws of thought; 2d, Sensation; 3d, Feeling; 4th, Intelligence.

[3] Leipzig, vol. I (1859), II (1860), III (1862), IV (1864), V and VI (1865–72). These last two were written or completed by George Gerland. A new edition of this work has been (1885-Tr.) published by Gerland (Leipzig, Fleischer).

The vague title *Anthropology* may properly be applied to investigations of many kinds. The study of man in his physical, moral, social characteristics, in his development and migrations, is an attempt so vast, so unlimited, that it really absorbs all the human sciences. In fact, anthropology rests upon an illogical and arbitrary conception. Every exact science has for its object a group of determined phenomena that it studies wherever it finds them. So anatomy, physiology, psychology, ethics, proceed: they pertain to certain facts and they pursue these facts in the whole animal series, indeed, in all life. Anthropology, on the contrary, is occupied not with a group of phenomena, but with a species: its unity is factitious, inasmuch as it exists only for man and by man: it is not as much a science as a body of facts drawn from other sciences. Thus books on anthropology treat only a small part of that which their title promises. They are only treatises on the comparative anatomy of the human races: all the rest is treated incidentally or omitted. Waitz—and this it is that characterizes him—labors especially on the psychological side: he has put in the first place what other anthropologists mention only incidentally or not at all.

We cannot deny that his work has been in part superseded; especially is this the case with the first volume, which is devoted entirely to general questions, and which had the misfortune to appear a few months before the *Origin of Species*. The psychological part of this volume (p. 296, etc.), although very extended, is now equally out of date. For Waitz, two principal problems arose: Has man a specific character? Are there specific differences among the races?[1]

To the first question, Waitz replies that the psychological characteristics peculiar to man can not be expressed in any one of the proposed formulas, such as that of perfectibility. He makes of them four groups: man subdues nature to himself by work; he employs articulate speech; he has emotions that serve as the basis of his social life; he has religious conceptions.

On the second point, Waitz studies at length the psychological variations of the human races by means of variations in the skull; he finds no profit in this and concludes that, for psychology, there are no specific differences among the human races (*dass es keine specifischen Unterschiede der Menschenracen in Rücksicht des geistigen Lebens gibt*, vol. I, p. 393). Whence, then, does it arise that there are such great differences among them in matters that pertain to general culture and civilization? For if we decide that differences are not original we must inquire how they are acquired.—For Waitz, all is explained by climate, migrations, and religious ideas; but above all by climate, which is the only first cause: the primitive difference from which all other differences, of food, dwellings, occupations, political affairs, etc., logically proceed.

Without going farther, one sees that most of these assertions could not be maintained to-day, or, at least, that the facts tend the other way. The five volumes devoted to descriptive anthropology, on the contrary, remain still the finest collection that exists, excepting monographs, for the study of the races in a state of nature. Special publications have completed or corrected the work of Waitz in many points; but no work has superseded it as a whole. His second volume is devoted to the negroes and kindred races (Nubians, Abyssinians, Gallas, Malgaches, Caffres, Samalis), their material culture, family life, political organization, customs, religion, intellectual qualities, temperament, and character.[1] A similar study (vol. III, 10–IV) is devoted to the aboriginal races of America from the Esquimaux to the Araucans and the semi-civilized peoples of Mexico, Peru, and Central America. The last two volumes are devoted to the Oceanic races. They are in great part the work of Geo. Gerland, Waitz having died at the age of forty-three years, May 21st, 1864, leaving his work unfinished.

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[1] It must be added that this concerns Waitz only from a point of view purely psychological.

Waitz visited none of the peoples that he described; but drew his data from travellers in these countries. No one, moreover, ever had a more lively feeling of the greatness and difficulty of his task. He coveted for the accomplishment of his work, says Gerland, the combined powers of the zoologist, geologist, psychologist, and linguist. His critical judgment throws light everywhere. He understands that the accounts of travellers may often be unreliable; that the psychological investigation of the inferior races has been conducted entirely from a standpoint of conjecture.

We commit the geological study of a country to a geologist, the study of its flora to a botanist, the anatomical study of a race to an anatomist; but for the study of the psychological characteristics and customs of a tribe it seems to many men that there is no need of preparation or special faculties of observation. And yet no investigation is more difficult. It is necessary, through the medium of languages rude and unfamiliar, to interpret feelings entirely different from ours; it is necessary to resist the impulse—natural to amateurs—to ascribe to these races our own customs of thought and feeling; it is necessary to separate their true religious beliefs from the mysteries with which they are entangled: in short, it is necessary to translate continually from a text whose every word suggests an opposite meaning.

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[1] See especially a very good description of the negro with his sudden and violent passions, p. 202, etc.

III.

Waitz collected facts, but did not arrive, as it would seem, at a clear conception of the psychology of the races. He studied especially the lower forms of human development, a study that will be, perhaps one day, as fruitful as that of the lower organisms has been in zoology. And it is safe to say that a premature death prevented his going farther. Others, after him, have digged in the same furrow: Lazarus and Steinthal. These may be considered the true founders of the ethnic psychology.

Steinthal is known by works on the languages, in which he shows discouraging metaphysical tendencies. He has written on their origin, development, classification, on the relations of grammar to psychology and logic. He is everywhere convinced of the existence of an *Allgeist*, a collective spirit, the condition and support of all society and the basis of moral life, whose law is to be sought not in the individual soul, not without, nor above humanity. Lazarus, to judge him by his principal work,[1] has less the manner of a psychologist than that of a moralist, using the word in the sense that the literary critic with us has given it. This book is a series of elegant essays containing fine remarks on *humor* as a psychological phenomenon, on tact, honor, and glory, on the relations of the arts among themselves, on education and science, on language in its relation to thought. We find deep erudition in it, agreeable traits borrowed from the romancers and poets, but nothing that resembles a rigorous scientific method, no classification of facts or earnest search for laws.

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[1] *Das Leben der Seele, in Monographieen über seine Erscheinungen u. Gesetze*, 2 vol. The first edition appeared in Berlin (Schindler) in 1856–57. A new edition has since appeared (Berlin, 1876–1878–1882, Dümmler). We will mention also his *Ideale Fragen*, 1878, and his monograph *Ueber die Reize des Spiels*, 1883.

These two men, however, have fixed the object and determined the sphere of ethnic psychology. They have founded, even, a special *Review*, to furnish its documents and constitute its literature. Established in 1859, the *Zeitschrift für Völkerpsychologie und Sprachwissenschaft*, is in its tenth volume—very little for nineteen years. It proposes to publish essays toward the discovery of the laws of ethnic psychology, and reports of historical, ethnological, geological, and anthropological facts; to study language, "not as the philologist or the empirical linguist, but in order to discover, with the aid of physiology, the psychological laws of language." This *Review* has fulfilled its promises.

Three essays of the first importance explain under different forms the conception of the ethnic psychology.[1]

In addition to ordinary psychology, which deals with individual man, there is room for another science, devoted to social man, or, more exactly, to groups of men; it is ethnological psychology. That this may have a real object, that it may not be merely words without sense, a "simple form of speech," it must be proved that the study of the individual is not sufficient. At first sight, we may say: Every social group is composed of individual elements; study these elements—which is the end of psychology—and all will be explained. This is a very simple thesis, but it does not deceive by an appearance of clearness. If it be true that the social whole is something else than a simple addition of individuals, if the formation of groups gives birth to new relations, to new forms of development; briefly, if the whole be not an arithmetical sum of units, but a chemical combination differing from its elements, it must be admitted that *Völkerpsychologie* has a province exclusively its own. And this is the truth. The social whole differs as much from each of its parts as the laws of political economy differ from the principles of domestic economy urged by a father upon his son, by a teacher upon his ward. Take a single tree, says Lazarus; it constitutes an object of study for the botanist: but plant some square leagues with fifty thousand trees; it is a forest, and this forest, as forming a whole, becomes the object of another science; that of forestry, a science which rests without doubt on the physiology of plant life, but which has, nevertheless, an end and means of its own.

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[1] *Zeitschrift*, etc., Vol. I, Int.; vol. II, *Verhältniss der Einzelnen zur Gesammtheit* (republished in *Das Leben d. Seele*, 2d Ed.); vol. III, 1st art., *Einige synthetische Gedanken zur Völkerpsychologie.*

The people taken *en masse*—in an assembly, a public gathering—have certain peculiarities of life that each individual alone has not. Whence do they come? Are they born of the mutual relations of individuals? Are they infinitely small increments manifested only in the integral? History shows us likewise that a people may differ in character from the individuals that compose it. "Note the Spaniards. Individually, they have an ingenuous good-nature, as we see in their romances; they are capable of nobility, and even of sublimity of character; but as a nation they have shown themselves destitute of the sentiment of justice and cruelly fierce. As a nation, they have devastated and depopulated America and the Netherlands; they have ruined themselves through their political and religious prejudices. Their nationality is embodied in Pizarro and the Duke of Alba. A nation is then quite a different thing from the *ensemble* of its individual members." In whatever way we explain this difference, it exists, and the single fact that it exists affords ground for the psychology of races.

What is the nature of this *Volkgeist*, of this spirit of a people, thus presented for study? Lazarus and Steinthal reply in a rather mystical style, "that it is not a substance, but a subject"; that it is "a monad that penetrates and combines individuals"; that it is an "objective spirit." In other words, whenever men form a group, live together, constitute a society, there arises from the *consensus* of individual (subjective) spirits a common (objective) spirit, "which becomes at once the expression, the law, the organ of the subjective spirit." Let us take, for example, one of the elements of the *Volkgeist*, language: it is at first an individual product; but it soon becomes the objective expression of individual thought; its *law*, because it is the given form of thought, and further, its *organ*, because it is the instrument of all subsequent progress in language. The same remark may be made concerning all the other elements of the social spirit. From the *consensus* of these different elements, from their action and reaction, results the formation of a physico-psychical type which is the national *résumé*.

This "objective spirit" has a support (*Träger*). Is it the totality of individuals? To Lazarus, it is simply their mean. In a nation, it is necessary, at first, to exclude children, for in them the development is not complete; on the other hand, to exclude exceptional geniuses; in short, whatever is too low or too high. The mean that remains is the support of the objective spirit.

A point treated with clearness by Lazarus and Steinthal is the determination of the elements that constitute the *Volkgeist*. These elements are language, mythology, religion, culture, popular poesy, writing as the basis of the historic consciousness, art, practical life, customs, statute law, occupation, family life, and finally, the reciprocal action of these different manifestations. The study of these constitutes the work of the psychology of races. Its concern is to arrive at psychological knowledge of a people in its spirit and action, "to discover the laws according to which its ideal activity—in life, science and art—develops, extends, or contracts, rises or falls, is refined and vivified, or is weakened and benumbed. To embody reality, the psychology of the races may not give a vague and arbitrary table of the internal (psychical) qualities of a people, but must discover the source whence they all flow. It must lay hold not upon such and such particular and accidental directions of its development, but its totality, with the laws that rule this development" (*Leben der Seele*, vol. I, pp. 337–338). It must explain especially the formation of races, determine the causes that have broken the human family into different peoples, and show, teleologically, what profit the spirit of man has derived from its development (*Ibid.*, p. 335).

The natural sciences set out from natural history. By an analogous process, the history of man can be raised to the rank of a science, and the process of transformation ought to be the same in the two cases. Psychology is to history what biology is to zoology and botany. The laws of biography, that is, of the development of the individual mind, ought to be exhibited in the psychology of the individual mind; so the laws of history, which we may call the biography of nations, ought to be exhibited in a comparative psychology which constitutes the true science of history.

Here is a noble program, well defined. The *Zeitschrift für Völkerpsychologie* proposes to fulfill it. Up to the present, we cannot say that it has succeeded. It has furnished a number of documents; but we seek in vain for exact results. The articles that it has published in the nineteen years of its existence seem to be capable of the following classification: history of religions, literary criticism, linguistics, anthropology, history of customs, law and politics, pure philosophy.[1] Judging from their titles, many of them are attractive, but they are treated in a manner as much literary as scientific. Often they appear too general for this kind of investigation, stripped too far of peculiarly philosophic conceptions. Without doubt, the task undertaken is so great, and the problem to solve so difficult, that twenty years of effort is very little; but is it unreasonable to ask that some generalizations, at least provisional, on particular points, should have been established by these researches? Is it not the first duty of the promoters of this work, to make out from time to time balance sheets of their results?

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[1] We give the titles of the principal articles; they are better than any commentary in helping the reader to understand the spirit of the magazine.

The original form of the myth of Prometheus.—The myth of Samson and the myth of Hercules.—Relation of religion to mythology.—Origin of myths among the Indo-Germanic peoples.—Mythological representations of God and the soul.—Popular poetry in Italy.—The theatrical nature of French art.—The Gothic style and the nations.—Hungarian poetry.—The rise of subjective poetry among the Greeks (Archilochus, according to the author, was the first subjective poet).—Homer and the *Odyssey*.

Articles on linguistics are very numerous; notice, Assimilation and attraction in language.—Idealism in the science of language (Language is the conception of the world peculiar to a people).—The Coptic language.—Pott vs. Steinthal on the subjectivity of language.—The dual among the Shemetic peoples.—Outline of a comparative syntax.

The centre of civilization in antiquity.—Geography and psychology.—The language of gesture.

The origin of customs (Lazarus considers them a result of social existence).—Ideas in history.

On nationality.—Influence of dwellings on moral conduct, based on statistics.—The legal condition of woman in the ancient Roman and German law.—The principle of nationalities in Italy.—The ancient German empire.

Plato's theory of ideas.—The controversy between Trendelenburg and Kuno Fischer.—Poetic imagination and the mechanism of consciousness.

The principal co-laborers, besides Lazarus and Steinthal, are *Delbrück*, *Tobler*, Cohen, etc.

The English anthropologists, with whom we are not further concerned here, appear to have apprehended better the conditions of a psychology of the races. They have sketched it in monographs. Anxious, above all, to collect facts, they have yet drawn interesting conclusions. Thus Lubbock and MacLennan have studied the primitive family; Tylor attempted to prove that the first stages of civilization are always uniform, whatever be the race, time, or country. We advise some laborer on the *Zeitschrift für Völkerpsychologie* to employ similar materials in the *Review*.

Stuart Mill, in the book that he devotes to the logic of the moral sciences,[1] treats of the method of ethology, that is, of the science of character, including in it the formation of national or collective character, as well as individual. He makes it entirely a deductive science. According to him, psychology founded on observation and experience, discovers the fundamental laws of mind; ethology determines the nature of this product, conformably to these general laws, in a body of moral and physical circumstances. It would be interesting to know what the representatives of the *Völkerpsychologie* think of this method; for, though they are explicit enough as to the object, the end, and the elements of their science, they have not been sufficiently explicit as to the method. They seem to have aimed especially at the collection of data, and in this they have shown themselves more empirical than Stuart Mill himself. But we must not censure them: these studies of detail will have their use; they deserve to be continued, and their promoters have an assured place in the history of contemporary German psychology.[1]

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[1] System of logic, book VI, ch. 5.

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[1] Among the representatives of the *Völkerpsychologie*, we may further mention Bastian, who has written many works on this subject. Yet his *Mensch in der Geschichte* (3 vol. Leipzig, 1860) is as much a book of anthropology. As for his *Beiträge zur vergleichenden Psychologie*, *Zur naturwissenschaftlichen Behandlungsweise der Psychologie*, and other works, they are far from giving what their titles promise. They consist of a collection of essays on the worship of ancestors and manes, on the different conceptions of the spiritual principle among primitive peoples, on property, priests, medicine-men, etc. It is an inextricable medley of facts, in which the beliefs of all the savage races, and of all the ancient nations, are often heaped up upon the same page.

CHAPTER III.

LOTZE.

The Theory of Local Signs.

I.

In a study of empirical psychology in Germany, it is equally impossible to pass Lotze in silence and to treat him with thoroughness. In general character and in tendency, he is above all a metaphysician; in education and profession, he is familiar with physiological research. At the age of twenty-two, after having studied philosophy and medicine with equal enthusiasm, he was charged, as *privat-docent*, with this double instruction in the University of Leipzig (1839). In the years that followed, his publications showed marks of this double course of study. He contributed to a dictionary of physiology (*Handwörterbuch der Physiologie* of Wagner) important articles, quoted to-day; he published a *Treatise on Pathology and General Therapeutics* (1842), a *Physiology of the Physical Life* (1851). And at the same time he made ready a *Metaphysics* (1841), a *Logic* (1843), and a *Medical Psychology* (1852). From that time metaphysical tendencies seemed to prevail more and more with Lotze, as is seen in his *Microcosm*, now in its fourth edition,[1] his

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[1] *Mikrokosmus: Versuch einer Anthropologie*, 3 vol., Leipzig, 1856–64; 2d edition, 1869–72; (3d ed., 1876–80. The first volume only of the 4th ed. has appeared, 1884.—Tr.). The divisions of the work are: body,

History of Æsthetics in Germany and the *System of Philosophy*, devoted to logic and metaphysics.[1]

The greater part of his work then is entirely outside of our subject, and we have nothing to say of it here. His psychology itself falls only half within our plan. Lotze, in fact, although employing experience largely, never separated psychological researches from metaphysical hypotheses, and we can say without hesitation that the "psychology without a soul," which has gained a goodly number of adherents in Germany, in later years, never had his entire allegiance. It is, yet, in truth, a physiological psychology that he has attempted under the rather singular title of *Medical Psychology*, and, such as it is, at twenty-six years from the date of its appearance, it remains the book that acquaints us best with Lotze as a psychologist, and assigns him a place in the contemporary movement that we are discussing.

Of the three volumes of this work, the first is devoted to pure metaphysics.[2] Of the rest, much has grown old; the author, we believe, would not hesitate to admit it. Not to speak of the physiology of the nerves, very different now from what it was thirty years ago, the manner of approaching or stating different problems is entirely different since Fechner, Wundt, Helmholtz, have treated them. An analysis of the *Medical Psychology* would be out of place. We will present only that portion of the work which is now most valuable. Let us lay aside

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soul, life, man, spirit, course of the world, history, progress, connection of things. In this body of questions so different, the problems of psychology are as often touched upon as treated. (English translation by Eliz. Hamilton and E. E. C. Jones, London, 1885.—Tr.)

[1] Theil I, *Logik, drei Bücher von Denken*, 1880; II, *Metaphysik*, 1879. (English translation under supervision of Bosanquet, Oxford, 1884.—Tr.)

[2] Translated into French by M. Penjon under the title, *Principes de Psychologie physiologique* (*Bibl. de Phil. contemp.*).

the metaphysics of the author. We will omit also the studies on sensation, feeling, will, which are necessarily found in every psychology, and which have since been presented in a larger form in Germany and elsewhere. These questions excluded, we will enquire only into a single point and examine its details: the theory of *local signs* and the perception of space. This is really the most original part of the *Psychology* of Lotze, the part that still lives, accepted, or at least discussed, by the best thinkers, and whose influence is to be found in all contemporary discussions. Wundt has admitted it by modifying it; Helmholtz[1] considers it the first decisive step toward bringing physiologists to the opinion that the perception of extension is not inborn, but arises from experience.

It is the exposition of this unique question, then, to which we now turn. Yet, inasmuch as it is difficult to separate entirely the experimental study from the metaphysical hypothesis in the *Psychology* of Lotze, and inasmuch as his phraseology presents an ontological character, and cannot be changed without altering his teaching, it is necessary that his method, which is neither purely speculative nor purely empirical, be explained to the reader.

What strikes us at first sight in Lotze is his profoundly metaphysical turn of mind. Nowhere does he treat psychology as a science of the simple phenomena of the soul. He reckons of only second importance the investigations peculiar to the sciences of nature, that are concerned only with the outside of things. "We have," says he, "two kinds of scientific knowledge. We know, on the one hand, nature, the essence of the object studied; on the other hand, we know only the external relations that are possible between it and other objects. In the first kind of knowledge, there is a possible question of a *cognitio rei* only when our intelligence apprehends an object, not simply under the form of external being, but in an intuition so immediate that we are able, by our senses and ideas, to transport ourselves into it, to penetrate its peculiar nature, and consequently, to know what ought to be, according to its internal and specific essence, the order of such a being. On the contrary, the other scientific kind of knowledge, the external, *cognitio circa rem*, does not penetrate to the essence of things, but consists mainly in a clear and precise apprehension of the conditions under which the object manifests itself to us, and under which, in consequence of its variable relations to other objects, it is regularly transformed."[1]

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[1] *Optique Physiologique*, French trans., p. 758. (German ed. p. 505—Tr.)

There is no one who does not admit with Lotze that knowledge of the essence of things is more valuable than knowledge of the internal or external events that manifest them. But unfortunately, we do not see that we are anywhere given the means of attaining it. It would have been remarkable, indeed, if Lotze had been able to show to the supporters of the psychology based upon phenomena alone, not that their knowledge is limited—this they know very well—but that another kind is possible, and that the hypothesis of a soul considered as a substantial principle adds something or other to our knowledge, and to the intelligibleness of internal phenomena. In psychology, if the *cognitio rei* consists in the affirmation ever repeated, but never established, of a principle that feels, thinks, desires; better still is the *cognitio circa rem*. To cope with the empirical psychology, Lotze must be able to prove that a science worthy to bear this name—that is, something else than mere opinion, individual taste, feeling, desire of the heart—can be more than a statement of simultaneities and successions of relations among states of consciousness; he must be able to show that it is not the so-called *cognitio circa rem* that constitutes *alone* what is generally known as scientific knowledge.

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[1] *Medicinische Psychologie*, vol. I, p. 50.

This proof he has not given, and he himself recognizes the equivocal nature of his position when he says "that we are able[1] to attribute to ourselves, almost with equal reason, the most profound knowledge of the soul, and, from a scientific point of view, the most complete ignorance," and when he attempts to place himself in turn at two contradictory points of view for constructing psychology. We find everywhere in him a powerful and fruitless effort to reconcile two irreconcilable tendencies; one of which consists in employing rigorously a scientific method, relying upon the results of physiology, and following them as a conducting thread; the other, in abandoning this method entirely and postulating an entity, "the soul," under the claim of faultless evidence, absolute certainty, as a truth known immediately, and thereby placed above all proof. As we would expect from a mind so profoundly metaphysical, it is the nature of this mysterious entity that is all important in his eyes. The rest, subordinate and accessory, is of value only in proportion as it assists us here. If we compare the work of psychologists to a voyage of discovery, we may say that, for Lotze, the true continent is the undiscovered one.

"If we wish to present, in our way of thinking," says he, "the ideal of the science, we must consider psychology the science of the essential principles of all being and all action; physics, on the contrary,[2] as the science of the forms the spiritual life assumes in its development in the domain of the relations of time and space. But if we wish really to contribute to the progress of the science, we must content ourselves, as too often the gaps in human knowledge necessitate, with possessing this principle in part, and in part submitting the great diversity of empirical phenomena forthwith to the highest laws that abstraction can obtain, to prepare, little by little, for the moment when it will be possible to deduce these phenomena from the true principle, the loftiest of their existence."[1]

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[1] Work quoted, trans. Penjon, p. 62.

[2] Physics is, for Lotze, the type of the *cognitio circa rem*.

This passage, so strange for a psychologist, signifies, if we understand it, that the ideal of psychology would consist in becoming pure ontology, but that for the present it must be content to explain the known by the unknown, the given by the supposed, the real by the imaginary; in short, that the laborious results of empirical psychology are an illusion and a snare unless they borrow their light from this "reality known immediately," which for Lotze and his followers is a source of revelations inaccessible to the rest of us.

Without going further we see what embarrassment results in the construction and exposition of a doctrine of psychology from the employment of such a *mixed* method, as we have called it above. We might define it still better thus: a process that consists in part of employing the scientific method, in part, under pretext of doing better, of neglecting it altogether. Lotze offers us the spectacle of a man caught continually between his science and his tendencies, between his positive knowledge and his habits of thought. He puts metaphysics very high without being willing to renounce facts; he lays much stress on facts, but subordinates them to metaphysics: and he never succeeds in uniting these two dissimilar elements, which, in whatever way he attempts to join them, demand only that they be separated.

He is, however, a vigorous and penetrating thinker, and it is only just to do him rightful homage. To sift a question, turn and return it on all its sides, to perceive all possible hypotheses, and discuss their degrees of probability, he is without an equal. His manner of writing shows it. A dialectician of marvellous subtlety, he distinguishes and divides to excess, recalling at times the method of the scholastics, sometimes also advancing in phrases that are vague, general, of noble swing, after the manner of the French spiritualists; but we constantly regret the scarcity of facts and examples.

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[1] *Medicinische Psychologie*, loc. cit., p. 58.

When he is concerned with a definition of the "essence of the soul," a question that is very dear to him, he spends so much time warning us of false solutions, bad methods, mistaken points of view, the custom of speaking of the spirit as we speak of matter, in combatting opposing definitions, that what he himself says on the point is reduced to very little, and the result of a great effort is merely a negative impression. He puts us in mind more than once of the saying of Montaigne of one of the ancients: "What juice and marrow he has in him are dried out in the process of cooking."

We have tried to show that the psychology of Lotze is embarrassed at each point by his metaphysics. It would be outside our purpose to explain his metaphysics at length: some lines will suffice. Lotze can be looked upon as a representative of the doctrine called in Germany *Idealrealismus*, a term that is applied to the schools holding a middle place between idealism and realism. If we consider Schelling and Hegel typical idealists, and Herbart and his disciples typical realists, we will notice that their fundamental point of divergence is this: Is the original element the *idea* or the *thing?* Does thought regulate things, or do things regulate thought? Ideal-realism considers the solution false that is committed to either the one or the other of these alternatives. It postulates parallelism between thought and being, but not identity. It admits facts as foundation and point of departure; but, advancing upon this, it aspires to the conclusions of idealism. Lotze occupies a position of this kind in German speculation. A naturalist and physician by education, a poet and artist in disposition, he sets out with facts, but allows himself to be carried away by his aspirations after the ideal, beyond the limits of the physical world. He distrusts the purely idealistic solution, but fears materialism and a mechanical explanation of the universe still more. Besides, in his metaphysic, feeling, æsthetic taste, and religious convictions, play a great role: among all hypotheses he accords undisputed prerogative to that which satisfies most of our moral needs.[1] From this *ensemble* results a doctrine a little vague in outline and difficult to reduce to system, yet clear enough in its general impression.

II.

The *Psychologie* of Lotze, setting aside the first part, which is devoted entirely to insoluble questions of metaphysics, and the last chapters, in which the psychology of disease is rather touched upon than treated, embraces the following questions: the study of simple sensation, feeling, movement, and instinct; the rise of the intuition of space; consciousness, its different states and the conditions of its development. As we have said above, we wish here only to examine a single point.

It is necessary from the first to understand well the object that Lotze sets before him in his chapter on the *räumlichen Anschauungen*. He does not propose to explain the notion of space, considered as an original and irreducible form of the mind. He declares himself very clearly on this point. We can reproach him only for not having shown in the beginning of his exposition, this important distinction which is manifest throughout, and which takes the form of remarks in the course of the discussion. It is a fault of composition that is very embarrassing; for, as a result, some uncertainty arises in the reader's mind as to the object the author proposes. At first glance he seems to be engaged upon a "deduction" of space, upon an elementary analysis whose object is the reduction of space to a simpler notion—a reduction that some of the empirical schools have attempted. But not so. "It is not at all our project," says Lotze,[1] "from these local signs to deduce the soul's faculty of perceiving *space in general*, nor the necessity it is under of apprehending the thing felt in this notional category. We presuppose, on the contrary, that there are in the nature of the soul grounds by reason of which it is not only *capable* of a notion of space, but is further *compelled* to apply this notion to the content of sensation, and we seek to explain by hypothetical physiological relations, between the local signs, neither this faculty nor this compulsion. Yet, while we accept and hold as a fact to be recognized from the first, that the soul *is able* to form these ideas of space and *consents to it;* it remains to ask further on what principle, in this general idea of space, its discrimination is guided in assigning one sensation to such a place and another to another, and how it is led to regard the sensations *a* and *b* as contiguous, the sensations *a* and *c* as remote in their relation to each other."

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[1] *Wo zwei Hypothesen gleich möglich sind, die eine übereinstimmend mit moralischen Bedürfnissen, die andere mit ihnen streitend, kann Nichts die Wahl zu Gunsten der letztern lenken.* (*Medicin. Psych.*, p. 26.)

The general intuition of space is then assumed as an original fact and placed above all explanation. Yet it is not to Lotze a kind of entity prior to experience. "We must not imagine that, before the soul receives external impressions, it spreads out, like a net ready to catch anything that falls into it, the intuition of infinite space of three dimensions entirely formed and already complete. The question would arise again, how do we get impressions to enter a net like this spread in a world where as yet they are not. The power of responding to the action of luminous waves by the sensation green or red is explained only as a manner of reaction peculiar to the nature of the soul and innate, affording room for no deduction whatever. After having experienced these sensations, we construct the general idea of color. It is the same with space. We do not have at first the vacant intuition into which the images of things that affect us are to be subsequently placed; but, reacting according to the laws of our nature against excitations already experienced, we commence by localizing an impression *p* near another *q*, by imagining a line *mn* that can be called an element of the future space, but not a line in space, for the entire space in which it would then be traced does not yet exist. It is later, upon observing what we have done, or what is done in us, that we conceive of the possibility of uniting two of these lines *pq*, *rs*, by two others, *pr*, *qs*, and that, by continuing our observations, we acquire the conviction that the possibility of thus connecting two given points has no limit. So the intuition of infinite space is formed; it is the result of the combination of elementary reactions native to the soul and belonging to it, as is said, *a priori*."[1]

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[1] *Medicinische Psychologie*, book II, § 292.

It is then well understood that Lotze does not attempt to explain the *empirical genesis* of the intuition of space.

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[1] *Revue philosophique*, Nov. 1887, vol. II, p. 345. Lotze has given a more extended exposition and *résumé* of his theory of local signs in the *Medicinische Psychologie*. In the article from which this passage is taken, he replied to various objections that his theory had called forth. Another *résumé* is given by Lotze, in an appendix to the work of Stumpf, of which we will speak in Chap. V. It was published in 1873. 9 pages.

In order that our visual and tactile sensations appear to us extended, it is necessary and it suffices that there be within us the possibility and the necessity of co-ordinating them in a certain way. This admitted, what is experimentally the disposition that favors such a co-ordination?

The great, almost inevitable error, that is inherent in almost every theory of space, and against which Lotze wished to guard himself, consists in confounding the solution of the problem with its data. We never free ourselves from a *petitio principii;* to explain space, we always employ elements that contain this idea. The grossest form of this mistaken solution is the old hypothesis of *idea-images.* It is not sufficient to detain us, and no one would be willing to discuss seriously whether or not small copies of objects enter the "soul" from without. Yet this doctrine, in a much more refined and subtle form, indeed, meets us still everywhere. All the theories of space, in fact, admit more or less, that the form under which a quantity of simultaneous *excitations* of the nervous system follow one another in space, affords immediately the reason for a similar disposition of *sensations* in space.

To illustrate the critique of Lotze by an example, suppose the end of a rule be laid on the hand; a certain number of nerve extremities are excited, and the excitations are transmitted by the nerves to the *sensorium.* It is generally held that these excitations are then reproduced, not to say where or how, in the same order as the impressions received, in such a way that the series A, B, C, . . . Z, of cutaneous impressions, becomes a series *a*, *b*, *c*, . . . *z*, of internal states, the form of the first series giving the form of the second. It is thus implicitly maintained that each point of the hand touched by the rule is represented in the sensorium by an analogous equivalent. For visual impressions, consisting of images painted on the retina, there is a similar hypothesis, which it is needless to develop. In short, it is admitted that that which perceives in us—soul or brain—by whatever term it be designated, presents a reproduction of external impressions, modified, reduced, transformed; that each element of extension is perceived as extended.

Whatever metaphysical solution we adopt, whether we suppose with materialists that the soul is extended, or with idealists, that the soul is not extended, matters not, since the same error is always committed. In order to get rid of this perpetual illusion, it is necessary from the first to understand that our visual and tactile impressions *can be perceived only under the form of intensive states.* What each point touched transmits to "the soul" is not an extended image of that point, but an intensive modification, varying with the nature and energy of the impression. In order to perception the impressions of the rule placed on the hand must be wholly transformed, completely changed in nature: a totality of given *extensives* must become a totality of given *intensives*, and thus furnish to the soul the material of a reconstruction, a transformation anew of the intensive into the extensive. "The great advance here consists in no longer detaching from things their objective images, but introducing, in their stead, immediately into consciousness, subjective figures of excitation, with their special contour. Undoubtedly there must be supposed also, in the transmission of these figures to the soul, a point where their geometrical form disappears, leaving no traces, and where it is replaced in the soul by a *sum of intensive excitations*, which, like the pitch of sound, contain no indication of extension or of position in space. If, consequently, we obtain a notion of the position of external objects, it cannot be by means of *perception*, but by means of *the new reproduction of space.* In general, the extensive is transformed into the intensive. It is thus that the soul must first reconstruct, within, a new world of space, in which the images of external objects find a corresponding function. Just as a variable magnitude can decrease to *zero*, and setting out thence take a new increase; so it is absolutely necessary that the regular geometrical impressions disappear at a point where there is no longer space, to be reproduced again on the other side. Just as, further, a variable magnitude is developed anew, not because it reserves its former positive values to place them, so to speak, under the value *zero*, but because the law of its variation is applied in the temporary destruction of its positive value; so also the impressions conveyed to the soul are developed in a new world of space, not by obscuring in consciousness the concealed quality of space, but by exhibiting their capacity of maintaining in the extensive excitations of the soul, which have produced them, relations whence result anew, through the constitutive faculty of nature, images of the objects in question."[1]

If it be admitted that, when the peripheral impression, transmitted by the nerves, becomes a state of consciousness, it ceases to present an extensive character, it still remains to explain how each of the elements that constitute this impression conserves its peculiar character and its relations to the other elements; how it is differenced from them and associated with them: for, without such conditions as these, no reconstruction of space is possible. To this the hypothesis of local signs affords a reply.

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[1] *Medicinische Psych.*, vol. II, § 287. Lotze further compares the soul to a lens that focuses at an indivisible point all the rays reflected from a colored surface. At this point it would be no longer possible to distinguish the relative position of the rays, since they are condensed in a general glare. But beyond this point the rays diverge again and spread out on an inverted scale, a copy of the given surface. In this comparison, the convergent rays represent the nervous movements caused by an external impression; the point of concentration corresponds to the unity of consciousness; and the bundle of divergent rays represents the reconstruction in the soul of the previously destroyed relations of space. (*Revue philosophique*, vol. IV, p. 347.)

Tactile and visual sensations are the only sensations that imply—at least, in a clear and indubitable way—the notion of extension. Hence a great difference between them and sensations of hearing, taste, and smell. A sound, a taste, an odor produce modifications of our organs, that vary according to the specific character of these sensations; but they produce nothing more. Between a single sound and several identical sounds that affect us simultaneously, there is a difference only of intensity: each sound blends with those like it, without preserving its individuality; the intensity only of the sensation is reinforced. In the same manner, between the odor produced by one odorous molecule and the odor produced by thousands of similar molecules, between the taste produced by one sapid molecule and the taste produced by thousands of similar molecules, there is a difference only of less and greater. Such is the case with all the intensive sensations.

With extensive sensations, the conditions change, and the phenomenon becomes more complex. Without doubt, there are also variations in intensity here (compare, for example, a luminous point with a luminous body, a red point with a red cloth, contact at a point with contact of the whole hand); but a new character of the first importance is added to that of intensity: extension. Let us examine this new character.

To reduce the problem to its simplest terms, we will exclude all complication due to pain and pressure, and suppose that the head of a pin touches the skin, that a red point is painted on the retina. As in the case of intensive sensation, a movement of the corpuscles of touch and of the rods of the retina, a transmission of this movement, by the nerves, to the sensorium, is occasioned; but this tactile or visual sensation does not appear to us as a simple modification of ourselves; it is referred to a point of our body or to an external object; it is placed in space. In a word, there is here more than a sensation felt, there is a sensation localized.

The difference between intensive and extensive sensations becomes more striking still if, in place of a single point, many points of the skin or retina, as is most ordinarily the case, are simultaneously affected. There is produced no longer a fusion of sensations in a sensation more intense; but each, preserving its individuality, is co-ordinated with others and forms the continuity that we call extension.

If all the points of the skin in a case of contact, and all the points of the retina in the case of a colored surface, felt identical impressions in an identical way, it would be natural to admit that there is produced here, as in the case of intensive sensations, a fusion, and not a co-ordination of sensations. But as, in fact, there is no such fusion, it must be admitted that each point of the skin, each point of the retina, feels after its kind, that is, imposes upon the impression received a particular mark, as indistinct as you will. This special mark which differentiates each impression from others is the *local sign*.

How are we to conceive these local signs? "We are able at the outset," says Lotze, "to represent them, in general, under the form of a physical nervous process, associated constantly, in each part of the nervous system, with a variable nervous process, which at the same point, serves as basis for the qualitative character of the sensation." Leaving these generalities for a more exact determination: "We are able," says he, "in two ways to conceive a system of local signs from which a clear and geometrical idea of space would result: 1st. It could be made up of muscular sensations. Not only every position of a limb, but further every contact of one of its parts could be distinguished from that of another part by a particular combination of those light accessory sensations which are provoked at the points of special contact by the transmission of the excitation. 2d. Still, what would permit a much more complete and easy determination of magnitudes mathematically comparable, would be a *system of movements*, produced, perhaps, by the passage of the excitation, or, at least, by a tendency developing in the sense affected. Let us conceive some very sensible organ, so mobile that by the action of an appropriate muscular system, any one of its sensible points can be turned toward any and all directions of space; and suppose, further, that the influence of the excitation always awakes in some way these tendencies to movement: we see that each portion of the organ will have the power of attributing to its excitations a mathematically determined local sign, in a complete and entirely special way. Indeed, each portion would have the power of awaking a tendency to movement, determined not only in magnitude, but also in direction, in correspondence with the three co-ordinates of space: a tendency which does not recur exactly for any other portion, and which, however, in relation to every other similar tendency to movement, sustains a certain degree of resemblance, or difference, of elevation or opposition. These considerations lead us at once to seek the local signs not in the accessory passive states alone which each portion of the nervous system experiences in addition to the sensorial excitation, but rather in the movements which the same portions tend to provoke through their connection with the rest of the nervous system. The eye, as well as the sense of touch, will give us occasion to test the value of this hypothesis in explaining the notion of the world."[1]

To make these general considerations upon the local signs complete, it remains to ask what relation they sustain to consciousness. Although Lotze is not disposed, in general, to overestimate considerations based upon the unconscious, he is inclined nevertheless to assign them an important role; and one is not astonished that Hartmann has considered this theory of local signs[1] as proof of his doctrine. When we determine trigonometrically the position of distant points from the angle that the visual rays from ourselves to these points include, we make a perfectly conscious use of our local signs. In ordinary life when we refer a cutaneous excitation to a given point on the skin, by virtue of an association founded on experience, we have still a clear consciousness of the local sign. But, in most cases, it is not so. "When in the sphere of vision we localize colored points perceived simultaneously, the reason of this localization lies entirely outside of consciousness, and the local signs that we still postulate perform their functions unconsciously." The case is analogous to that of reflex movements, which enter consciousness only as accomplished facts. "Localization, in space, then, belongs to the unconscious product of the soul's action through the mechanism of its internal states."[2]

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[1] *Medicinische Psychologie*, book II, ibid., § 291.

Lotze has recently declared that he could not subscribe to the opinion of those who maintain that, his theory admitted, it is possible to verify the hypothesis of local signs by reflection and internal observation. "We do not forget," says he, "the uncertainty and arbitrary character of every hypothesis upon which phenomena are supposed, which exist in the soul, but exist unconsciously. We certainly have not the right to admit such unconscious states, at least to compare them with forgotten and reproduced ideas, the only examples of the persistence in the soul of that which persists no longer in consciousness. But in the case in hand I believe we have this right."[3] The skilled musician executes unconsciously acts that were at first conscious. "We are persuaded that it is the same with the localization of our sensations. It seems at present to take place suddenly, at the very instant that we open our eyes; but at the dawn of life this power is developed only by means of a series of experiences, which, if we could reproduce them, would enable us to see, as in so many of the states of consciousness of the child, all those intermediate states which have become imperceptible to the consciousness of the adult."

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[1] *Philosophie d. Unbewussten*, trans. Nolen, I, p. 371, etc.

[2] *Medicinische Psych.*, ibid., § 204.

[3] *Revue philosophique*, loc. cit., p. 360.

III.

After these general considerations upon the local signs, let us study, in order better to understand their nature, the role that they play in the formation of visual and tactile perceptions.

VISUAL LOCAL SIGNS.

Setting aside the numerous questions that attach to vision: estimation of distance, direction, right vision, union of images in one, etc., etc.,—we will consider a single point: the formation of the image on the retina. In this we follow the example of Lotze, who treats the other questions as mere accessories.

The excitation of any portion of the retina produces in "the soul" two corresponding states, the one determined to a color, the other to position relative to the point excited, which latter is itself relatively allied to that portion of the retina among its surrounding portions. Let us not forget, moreover, that this second state (that which corresponds to position) can present only an extensive character. The sensation corresponding to color *cannot have even the form of a point;* for, being without extension, it cannot be conceived as the negation of extension in space, that is, as a point; it is perceived only as quality, having neither a positive nor a negative relation to a development in space."[1]

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[1] Loc. cit., § 310.

The local sign, that concomitant of the sensation of color which prevents its losing its individuality, consists, as we have said, in a system of movements. To understand it, let us suppose that the image of a brilliant point is formed on one side of the retina: at the same time a movement of the eye takes place, by which the centre of clearest vision is placed beneath this image. We know, in fact, that there exists in the retina a small portion at the centre, which has a visual sensibility very superior to any other part. We know, also, that in virtue of a physiological contrivance, whose causes and origin it is not here our business to investigate, the excitation of any point of the retina occasions a deviation of the axis of the eye, in such a manner that the point of clearest vision is directed toward the exciting object.

This understood, let us call this point of clearest vision v, and suppose that three other points of the retina, a, b, and c are excited. The image formed at a will give rise to a certain movement, necessary to produce the image at v. The image formed at b will give rise to a movement different from av. The image formed at c will give rise to a movement different from av and vb. Whatever positions we assign to a, b, c, it is easy to see that, in any case, the movements will not be identical, that each will have a character peculiar to itself. Indeed, if we suppose that a, b and c are situated in the same line, or rather, in the same circular arc, the segments va, vb, vc, of this arc must have different magnitudes, and, as the eye must pass over them to bring in turn the images a, b, c, in the direction of clearest vision, there will necessarily arise muscular movements that are different in magnitude, though analogous in other respects. If we suppose a, b, c to be situated on the circumference of the same circle whose centre is v, then vb, va, vc, will be equal, but in different directions. Finally, if we suppose that a, b and c are situated neither on the same line from

v, nor on the same circumference whose centre is v, then va, vb, vc, will be at the same time unequal in magnitude and in different directions. "If we designate the sum of all these movements by S, this sum is for each point of the retina an unchangeable and definite combination, and so we believe that we have in it a local sign that differences the excitation at each point from the excitation at any other."

In the case that we have just examined, we supposed a lively impression produced at a point of the retina, and followed by a *real movement* of the eye. But, in cases where there is not a single predominating impression, each excitation of the retina continues none the less to determine a similar *tendency to movement* in connection with the point affected. "We may further admit that this tendency has at first for its end only the production of the automatic movements of the eye, but that it afterward produces a change in the state of the soul—an impression; and, to my mind, it is by means of these impressions, in accordance with their gradual and exact determination and the degree of their inter-relation, that the soul develops in space the perception of colored points, in such a way that their distance in the field of vision, and all their relative positions, correspond to the distances and positions of the nervous points excited. It is not necessary to require that these impressions be transformed into conscious representations. Although this is a fact in certain cases, we must consider the initial localization of the colored points an absolutely unconscious operation of the soul." Later, in consequence of habit, the colored points seem to be placed, of themselves, in determined positions, and their localization is not the result of a sensation antecedent to conscious movement, still less of real movement.[1] "Thus," says Lotze, "it is neither to real movements nor to their conscious sensations that we refer the co-ordination of points in the field of vision. The first localization, entirely unconscious, rests in the connection between the sensor and motor nerves, and it is the excitation of these latter at their central terminations that gives to each impression of color its peculiar local sign."[1]

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[1] Lotze returns many times to this point; that we attribute, according to him, to *real* movements of the eye, an exaggerated influence in the *development* of the notion of space. See in particular *loc. cit.*, § 328.

We will sum up in a few words the exposition given. The formation of the field of vision is possible only by a body (*ensemble*) of local signs. These local signs can arise neither from movements of the motor muscles of the eye, nor from the histological constitution of the retina alone, even allowing that each feeling point presents a structure slightly different from that of the surrounding points. The cause of distinction among the excitations of the particular points of the retina can be found only in their relations with the motor train. Each impression for each point gives rise to a particular movement (or tendency to movement), which produces a certain psychic state; this state constitutes peculiarly the local sign. Lotze attributes to these acts a character in general unconscious, but without disguising the difficulties inherent in such a hypothesis. Finally, when the excitation, the movement, and the psychic impression that follows, have been repeated a great number of times, there results a complete knowledge of the topography of the retina, of the position of all the points; this makes an immediate localization possible, even when the eye is in repose. This process approaches very near the reflex processes in its origin (excitation), its end (motor reaction), its automatism, and its unconscious character. To conclude with the words of Lotze himself: "It is from the combination of the excitations of the retina with those unconscious impressions which associate with them, in the soul, tendencies to movement, that we may deduce the co-ordination of points in the field of vision."[1]

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[1] *Medicinische Psychologie*, *loc. cit.*, § 312.

TACTILE LOCAL SIGNS.

It will be useless to dwell as long on this point as on the preceding. It will suffice to note wherein the two cases differ.

The corpuscles of touch play a role analogous to that of the cones and rods in the retina. There are differences in structure between them, at the outset, three kinds being distinguished (corpuscles of Pacini, of Meissner, and of Krause). Moreover, they are spread out or grouped in a very different way at different points of the skin. These facts in themselves are sufficient to explain the fact that the same excitation may vary according to the cutaneous region that it affects; but they do not explain localization. Qualitative differences do not explain the fact that the impressions are referred to certain points of the skin, and are co-ordinated in space.

These anatomical differences, then, are only the first conditions of localization in space. A second fact to which Lotze attaches great importance, is the phenomenon called "the wave of accessory sensations." As the skin forms a continuous surface, no excitation, however small, can be assigned to a point where it originates. It always occasions tension, pressure, displacement, small or great, in the neighboring parts. But the structure of the skin is not everywhere the same; it varies in thickness, flexibility, rigidity. The contact varies according as the affected part adheres to an osseous surface, or covers a cavity, or rests on the soft mass of the muscles. "Thus the sensation resulting from the excitation of a point A, is encircled by a wave of accessory sensations, determined by the form of this point, its extent, the composition of its elements, and differing in these particulars from the wave that accompanies the excitation of any other point B." It suffices to recall the celebrated experiments of Weber, to see that the tactile sensibility varies with the regions of the skin. At the end of the tongue and at the ends of the fingers, two points can be distinguished, and consequently present local differences, at as short a distance as one and two millimeters; on the back, the shortest distance is two to four centimeters. But we must not be deceived here: the waves of accessory effects, in spite of the important role they play in tactile perception, do not fulfill the conditions necessary to true local signs. They afford means of distinguishing two sensations, A and B; they do not suffice to distinguish them in space; *i. e.*, to construct a line of which A and B are the extremities.

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[1] *Medicinische Psychologie*, loc. cit., § 328.

There remains a third element: movement and the muscular sensations that accompany it. While recognizing the important, capital, role that this last element plays in the localization of the tactile perceptions, Lotze insists upon it less than his followers do,[1] and thinks that we cannot find in it a complete solution of the problem in hand.

To sum up, the skin is a continuity, varying in its surface, in consequence of differences in anatomical structure, of direct impressions and the auxiliary impressions that they produce, of movement and accompanying muscular sensations. In order that we may decide, says Lotze, whether an impression is produced on the right or on the left, it is necessary that the excitation of the sides of the body produce different sensations in consciousness. Beings of a completely symmetrical constitution would be incapable of distinguishing between the right and left, and in general, between corresponding parts of the body.[1] There are differences of structure, of movement in the members, of muscular sensation, that make the differentiation possible. We remark finally with the author—and this fact shows the importance of movement—that, if the extremities of the fingers be fixed upon the end of a rigid rod, all delicacy of localization disappears: each excitation instead of affecting a particular point, seems to be diffused throughout a homogeneous medium.

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[1] According to researches of which we will speak later, it is maintained that the delicacy of the sense of place is proportional to the mobility of the part of the body affected. See the chapter on Wundt below, § III.

We must not forget, then, that to Lotze, neither differences of structure, nor accessory waves, nor movement, nor muscular sensations, explain the localization of tactile impressions. For such localization, a synthesis is necessary: "it is necessary to possess already a geometrical image of the contour of the body and to have learned by experience to what point the sensations A and B are to be referred, according as they are affected with the local signs α and β."

A very natural objection arises here: the case of persons born blind, who acquire the notion of space by touch without the aid of sight. From the first, Lotze admits that the cutaneous sensations taken alone, though they do not give us the distinct idea of space, nevertheless give rise, in certain cases, to the obscure idea of a certain largeness which is not without some remote analogy to the idea of space. Further, when the sense of touch exists alone, the necessary conditions of localization are found in it, in virtue of the movements that accompany impressions; but these movements having neither the fullness nor delicacy of those that accompany the visual impressions, the localization is ruder and more imperfect. "The skin is possessed of innumerable sensitive points, but the movements necessary to estimate position are not immediately possible at these points, as they are at those of the retina, and it is necessary that the movable organs combine to supply this defect. The hand sliding over the surface of a body receives, like the retina, a great number of impressions at once. When it loses one p, it does not lose all; the others, q, r, s, persist, and a new impression t joins them:[1] thus it is that groping, together with the sensibility of the skin, serves to form for the blind a notion of space; but is perhaps not entirely identical with that which sight makes possible." Lotze, in effect, remarks that the faculty of differentiation, being much less fine in touch than in sight, the space of a square inch must offer to the blind fewer differentiable points than are discerned by the man who sees. It is concluded that, to the blind, objects ought to appear smaller than to one who sees; and, in fact, those born blind, when operated upon (among others the case of Cheselden), have many times expressed their astonishment at the unexpected size of objects.

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[1] *Medicinische Psych.*, loc. cit., § 340.

Lotze completes his theory of local signs with an inquiry into the genesis of the notion of externality. We will say nothing upon it, as this question is to be examined elsewhere. Our object was only to discuss a single point in the doctrine of Lotze: that which gives him true originality as a psychologist.

This doctrine of local signs has been adopted in Germany by a number of authors: admitted without reserve by some, modified by others.

The first merit that we must allow him is that he has brought to light all the difficulties inherent in the problem. No one has shown better than Lotze the *petitio*

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[1] We must remark with Lotze that the persistence of each impression alone renders the notion of space possible. If, in the passage from p to q, no trace of the former persisted, we could not establish those relations which constitute space.

principii[*] of the ordinary solution. By an almost unconquerable tendency of the human mind, we are wont to explain space by means of images that presuppose it. We see objects reflected in the retina as in a mirror, or imprinted upon the tactile organs as the stamp upon wax, and we think that these external images ought to be reproduced in our consciousness under forms more or less analogous. Reflection, however, teaches us that knowledge of these images supposes anterior knowledge of our body, of its parts, of their positions, in short, knowledge of relations in space, and that this knowledge can be itself derived only from states entirely internal. Lotze sees but one way of resolving this difficulty: we must refer the perception of extension to a perception of *qualitative* differences, which by a new reconstruction of the mind become relations of extension.

His hypothesis is natural and scientific; he has developed it in metaphysical language, which we have scrupulously respected for the sake of exactness. It is based on facts and is offered as their only probable explanation. Lotze undertakes to show that the anatomical disposition of the visual and tactile organs affords solid support to his hypothesis. "If we find," he says, "such a disposition as will assure the action of external excitations upon the nervous system, according to geometrically prescribed relations, this disposition will afford much reason for the belief that nature intended to deduce from these relations something for consciousness: this in itself, however, explains nothing." To our mind he has not insisted sufficiently upon this point. It is true that at the time the *Medical Psychology* was written the arrangement of the terminal organs for the visual and tactile nerves was not as well known as to-day. But, taking the question up again quite lately, Lotze has not insisted further upon these anatomic details. Physiologists seem now to admit that the structure of the peripheral nerve terminations plays a great role in the reception of impressions from without, and this position has some analogy to the hypothesis of local signs.

We have seen the important place that Lotze assigns to movement, in the formation of visual or tactile space, especially to unconscious movement, or, as he sometimes expresses it, to *tendencies*. This position invites criticism, especially from those who, ridding themselves of the unconscious, rest as much upon induction as upon well-established facts. "For the sake of brevity," says Lotze, "we will sometimes use the expression tendencies to movement, to designate the local signs. This expression has been criticised as ambiguous and incompatible with the precision that notions in a mechanic of psychic phenomena should have." This criticism leads Lotze to define his thought and to speak of the local sign as a purely psychic state of which movement is the occasion. "That which passes in the nerves can give only a rotation of the eye, i. e., a phenomenon of the physical world: the psychic affections that issue from it can alone bear the name local signs, for they alone produce localization, and localization is an act of representation with no relation of resemblance to any movement whatever, and cannot be in any way estimated in terms of the notions employed in a mechanic of body." Here again we fall into the difficulty of admitting as the last ground of our explanation a state which is considered at once psychic and unconscious. Yet it must be remembered that Lotze does not cease to repeat that his theory is presented only as an hypothesis.

Is this hypothesis true? To reply in the affirmative we must be able to show that it is the only hypothesis possible: now it is probable that Lotze himself would not maintain this. Besides, there is a difficulty involved in the whole discussion of space, i. e., the role that is played by the ultimate or *a priori* element, which he mentions only in passing, but which remains, nevertheless, the basis of all the work of mental reconstruction.

To sum up, his theory holds a middle place between the attempts which the English school have made to explain entirely, and by experience alone, the genesis of the idea of space, and the complete absence of explanation which has prevailed ordinarily among the defenders of an *a priori* intuition. The continued investigation to which the science is subjecting this notion, in the light of new theories and experiments, will determine its relative value. Whatever become of the solution of Lotze, it will remain the work of an ingenious and penetrating mind, one that is extremely apt, especially, in stating the difficulties of the problem.[1]

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[1] In an article recently published in the *Revue philosophique* (Sept. 1878, vol. VI, pp. 217–231), Wundt criticised very profoundly Lotze's theory of local signs, which he calls the hypothesis of *simple* local signs, in opposition to his own, the hypothesis of *composite* local signs. He reproaches Lotze for putting the question under a metaphysical form (hypothesis of the soul), and for deciding, in virtue of this hypothesis, that our retinal and cutaneous sensations cannot possess extension. He attempts, on the contrary, to show: 1st. That there are optic and other experiments that justify our refusing to the retinal and cutaneous sensations, taken in themselves, an extensive character; 2d. That the conditions that must be added to these sensations to place them in the category of extension are those of movement.

CHAPTER IV.

ORIGIN OF THE NOTION OF SPACE.

Debate of the Nativists and Empiricists.

WE have just studied with Lotze, in detail, a particular element of sensible cognition. Without leaving this problem, we must notice the debate of a question of much more general character, that concerns the very foundations of human knowledge.

Is the knowledge of extension and its determinations, length, breadth, thickness or distance, position, form, inborn or derived from experience? This is a question that has been asked and answered differently, especially by physiologists, and has given rise to numerous theories. Helmholtz, I believe, was the first to classify them as native and empirical. Doctrines on this subject really date back to the first attempts in psychology; but it is only in our day that they are constructed with a clear knowledge of the problem in hand, of the possible solutions, and with the substitution of reasons of fact, drawn from the natural sciences, for metaphysical deductions. The issue is joined particularly on the question of visual space. This was to be expected from the fact that sight is the most delicate of the senses, the richest in its reports of the external world, and the most open to nice experiment. The same question is raised, however, as to tactile space, and although we cannot cite on this point as many attempted expositions or debates as brilliant as those of Hering and Helmholtz on sight, the solutions are fundamentally the same. On this side the struggle between the nativists and empiricists, to which I will first call attention, has been less deadly and there is much less to say than on the question of visual extension; but for the reason that it is simpler the debate is more instructive.

We will expound the different doctrines, and then examine the theoretical question.

I.

TACTILE SPACE.

Reduced to their common content, the theories of *nativism* maintain that the order of tactile sensations has its basis in the constitution of the organism, that it is given originally with the organism, and is consequently innate. This hypothesis is the more natural, the simpler, and arises first in the mind. Any one who has not betaken himself to reflection or the thought of others adopts it confidently. It is a spontaneous belief, one of those predications that the Germans call "a product of the natural consciousness." It has been everybody's solution in all time.

The great physiologist, John Müller, seems to have been the first to give it a scientific form. It is generally admitted that he constructed his theory under the influence of the philosophy of Kant. Historically this influence is indisputable, although, in our opinion—we will attempt to show it later—the Kantian critique has no connection with this debate. Müller observed with reason "that the notion of objects of touch rests, in the last analysis, upon the possibility of distinguishing the different parts of the body as occupying each a different place in space;" but, according to him, if the optic and the tactile nerve alone among the sensor nerves, convey to the *sensorium* an impression of extension in space, it is because "they alone are capable of feeling their own extension in an exact way." "Since entire members, indeed the majority of the parts of the body, have sensor nerves, it results that the sense of touch is capable of apprehending, in all dimensions, the extension of the body; for each point at which a nerve fibre terminates is represented in the sensorium as an integral portion of space (vol. II, pp. 271–272).

The well-known investigation of E. H. Weber determined more exactly the role of the nerve terminations. He showed, using compasses with blunted points, that tactile sensibility varies extremely from one part of the body to another; that in order that two points be distinguished on the end of the tongue, a separation of a millimeter is sufficient, while on the back it must be from four to six centimeters. In this way he divided the surface of the body into a great number of regions, called circles of sensation, which vary extraordinarily in size and form. At first, Weber considered each of these circles, that is, each portion of the skin provided with a single nerve thread, as an unit of space. Later, replying to the different objections called out by his theory, he maintained that the circles of sensation must be such that there may be many between two points felt to be distinct; in this way he explained the space intervening in sensation between the two points. He gave to experience and habit a considerable role, admitting that they diminished the number of circles necessary to the perception of the interval between two points of the body. In so far he approached the empirical theory.

Other authors, among them Czermak and Meissner, made various modifications. But the one who has been more recently the most intrepid champion of the nativist theory, while pretending to reconcile it to its rival, is Stumpf. In his *Psychological Origin of the Notion of Space*,[1] he maintains that we have innate knowledge of three dimensions. At first, in all contact, we feel necessarily and immediately a certain extension; we localize the tactile impression in a definite place, needing no other condition than the contact itself. Thus we have intuitive knowledge of a surface touched. But it is curious to see the way in which he establishes his position for the third dimension. He says if the surface (length and breadth) be perceived immediately, depth must be also. In fact, the surface that we feel in contact with any part of our body must be either plane or curve; these are the two possible cases. Now, these two kinds of surface imply a third dimension, "for they report something that is related to depth: the presence or absence of an inclination (*Ausbiegung*) toward depth. It cannot be objected that this is true only of curved surfaces, and that the plane surface is, on the contrary, a negation of depth; for a negative concept contains all the content of a positive concept, plus a negation" (p. 177.) With such reasoning, the weakness of which is too apparent, Stumpf maintains that the new-born babe, when its body is encircled with a band, must have the idea of a curved surface, and consequently of three dimensions (p. 283.) He concedes, however, that this new-born babe has not all our notions of mathematical relations; but its primitive representation virtually contains them.

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[1] *Ueber den psychologischen Ursprung der Raumvorstellung*, Leipzig, 1873.

The *empirical* or *genetic* theory maintains a psychological evolution. Relying particularly upon the influence of association and habit, it refers the fact of tactile localization to experience, in accounting both for its completion and its origin.

The first hints of this doctrine are to be found in Locke, Condillac, Berkeley especially, and in general in those who are inclined to give as large a role as possible to experience. In this century, Herbart, for reasons purely metaphysical, referred, as we have seen above, the notion of space to a succession of states of consciousness that can be reversed, that is, read indifferently from A to Z, and from Z to A. He wished by this to explain the fact that the soul, supposed by him to be absolutely simple and unextended, can perceive objects that have extension and form. The movement of a limb produces in consciousness a series of states; it is this series that, as far as it can be reversed (not the movements themselves), suggests to us the notion of space.

In 1811, an author little known to-day, Steinbuch, in his *Beiträge zur Psychologie der Sinne*, submitted that movement alone could furnish the notion of space. His theory, applied by himself mainly to vision, deserves to be recalled; it contains in germ the doctrine maintained later with so much fullness and assurance by the English psychologists, especially Bain. We will notice it further on under the head of visual space.

But Lotze first transformed the empirical hypothesis into a profound and elaborate theory; it will suffice to notice it again in a few words. Each feeling point of the body has its local sign. This term implies no original localization or extension; it means simply that each tactile impression presents a particular character (*nuance*) that serves later to localize it at a certain point of the body. At first, these impressions are purely intensive, and present no special determination of any kind. Later, the mind, by virtue of laws peculiarly its own, transforms these intensive data into extensive quantities, and produces a "reconstruction of space." A psychological process plays the capital part in the genesis of the notion.

The most recent of the genetic theories is that of Wundt. He accepts the theory of local signs, but judges it insufficient; for how can a graduated series of qualitative local signs be transformed into a succession in space? Lotze explains this only by admitting the presence of *a priori* laws of mind. But, says Wundt, the different impressions are accompanied by movement, and thence results a feeling of innervation. These two elements—local signs and movement, with accompanying sensations—explain localization in space. Neither local impressions alone nor movement alone could give it; but the two, united in our mental chemistry, form, by a *psychological synthesis*, a combination which is the notion of space. The originality of Wundt's solution, then, consists in the idea that the notion of space is a synthesis of given elements; but each of these elements no more resembles space, the result of their combination, than oxygen and hydrogen resemble water.

II.

However dissimilar these theories may be, they have one result in common—they exhibit the problem in all its aspects, and enable us to state it more clearly. Setting aside the general considerations of the metaphysicians, the majority of the authors mentioned proceed by the examination of details; for an abstract discussion, they have substituted concrete discussions; instead of seeking for the origin of space, they endeavor to show by observation and reasoning the genesis of the ideas, length, breadth, distance, form, position, direction—in a word, all the determinations of extension. Their method is directly opposed to that of the metaphysicians.[1] Here is a fact to which, in our opinion, sufficient attention has not been given; many physiologists do not seem to have seen it clearly, though their habits of mind have nevertheless led them aright in their ignorance.

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[1] A good example of the opposition between the two methods is seen in the discussion of Stuart Mill with his opponent Mahaffy. Mahaffy maintains that direction cannot be used in an analysis of extension, "because direction implies space, and space cannot be used to explain itself." Mill replies: "Instead of direction implying space, it would be more proper to say that space implies direction. Space is the connected whole of directions, as time is the connected whole of successions; consequently, to postulate direction, is to postulate, not space, but the element from which the notion of space is formed."—*Examination of Hamilton.*

It may be objected that all this has no value; that these terms, length, direction, etc., convey a meaning only as they exist already in the notion of space, and this notion alone renders them intelligible. But even though this be granted—as it is by most writers—the position remains good. The questions we are dealing with rest upon problems of experience, not upon transcendental questions. We wish the empirical genesis of the notion of space; it is right, then, to go to experience for the solution.

If the study of the abstract notion of space be substituted for the concrete study of its elements, it becomes impossible to proceed analytically. The most determined adversaries of the physiological method cannot deny that, in this respect, it has done great service. Physiologists, indeed, resting upon experiment, the data of pathology, and cases rare enough to be instructive, have studied the role of each of the elements of tactile perception taken alone, have separated visual space from tactile space, touch proper from its accompanying sensations, and have determined the functions of muscular movement, and of the feeling of innervation. We will show this in more detail.

When we attempt to solve the question, "Does the notion of tactile space result from mechanism, or is it innate?" the difficulty of separating what is due to visual sensations arises at once. Sight and touch are two languages that we employ simultaneously from our birth, and they become so confused with each other that they seem but one. Further, the reports of sight tend by their superiority and richness of information to conceal those of touch. Recourse is left us to those who are born blind, and if some such were found endowed with talent for psychological analysis, they could give us a great deal of information. Yet they would misconstrue us, since terms would not have the same signification for them. This renders the observations of Platner's blind man, of whom we will speak later, sometimes very vague. Still many good observations could be made by critical examination. The study of operations upon those who were born blind has been very instructive. Since Cheselden there have been about a dozen cases, of which hardly half were adults. Despite contradictions in detail, these observations have shown that the patient knew neither the form nor distance of objects, and, consequently, that the data of tactile space are not the same as of visual space. It is known that Locke in reply to Molyneux drew the conclusion that if a man born blind should recover his sight, he would not be able to distinguish a sphere from a cube: but what was to him only an opinion, a probable conjecture, has now become, thanks to objective observation, an established fact.

Having thus established the point that touch has its peculiar way of arriving at the different modes of extension, we can go a step further and distinguish contact proper from sensations of temperature, pleasure, pain, etc. It is established that in certain diseases the patient is sensitive to the slightest touch, the tip of a feather, a breath, etc., but does not feel the pricking or cutting of the skin. Others, on the contrary, are very sensitive to pain, but cannot localize it, and do not feel touch. If the leg is pinched, they refer the pain to the hip, or even to the other leg. Sensation of temperature may be entirely wanting, the two other kinds of sensation remaining intact. Touch, then, can be considered as a complex sense; or rather as the union of many senses, of which contact alone concerns us.

Considering touch as contact simply, there is yet another element of capital importance to be considered—movement. The different parts of the body are movable, and the parts most easily moved are most sensitive to contact, for example, the hand. It is hardly necessary to remark that the possibility of moving the tactile organ in each of the senses makes it possible to know the form and dimensions of objects. The paralytic who feels but cannot move is incapable of active touch. By touch, in ordinary language, we understand, besides contact proper, the accompanying movement. Moreover, reflex and voluntary movements do not serve for the perception of external objects only; they give us from the first knowledge of the different parts of the body: those parts that move most easily, as the end of the tongue, the lips, the hands, possessing the power of finest localization.

But in touch, movement has a double function. It is not only a precise means of varying and multiplying points of contact; it is in itself a source of knowledge, because it is the source of psychic states that constitute a true muscular consciousness. Each movement has its own modality according to the nature of the muscles put in play, their state of vigor or fatigue, the direction of the movement (flexion, extension, rotation, etc.), its duration, intensity, and the degree of effort and resistance. Experiment shows that all these variations are transmitted—or may be—to consciousness.

Physiologists have differed much as to the seat and conditions of this muscular sensibility. These theoretical controversies are of little consequence: one thing is certain, and this is that we have a feeling of the state of our muscles. Pathology, further, through the study of cases in which this is wanting, testifies to the importance of this faculty. In some diseases the patients do not know the position, or even the existence of their limbs, when they no longer see them; they do not know whether they are extended or bent, and think they are without weight. In other cases, still more instructive, only the muscular sensibility remains. "In the case of a workman," says Landry,[1] "whose fingers and hands were insensible to all contact, pain, and temperature, the sense of muscular activity was everywhere alert. If I made him shut his eyes and placed a large object in his hand, he was astonished that he could not shut it; but his only idea was that there was some obstacle to the movement of his fingers. I secretly tied to his wrist a kilogram weight; he thought some one was pulling him by the arm." The only remaining state of consciousness was that of effort, under the form of resistance and traction.

A rarer case is the loss of the muscular sense, while sensibility to contact remains. Yet Landry (work quoted, p. 195) speaks of "persons who had lost the feeling of weight, resistance, and the different muscular movements, while sensibility to touch was normal."

We have now briefly enumerated the elements that unite to form our knowledge of tactile extension. By some examples, chosen from many, we have shown the function of each of these elements, and the result when they are deranged. This analytical process shows the complexity of the problem; it remains to study the genesis of the notion of space.

A general fact, underlying all physiology of feeling, seems at first sight to be capable of interpretation in favor of the empirical or genetic theory. And truly so, if it is well established, viz. that all sensation is really felt at the nerve centres and not at the point in contact. Tactile sensations, at the outset, are not transferred to external objects nor even to the periphery of the body. They are very probably felt as vague internal sensations and as obstacles to movement. It is not till later that they are localized at the point touched. Physiologists designate this general fact by the name "law of eccentricity of sensation"; meaning that what occurs really at the centre is projected to the extremities. This fact seems to support the fundamental position of the empiricists, as Helmholtz has formulated it: "Sensations are signs in consciousness which it is the function of the intelligence to interpret." It seems true, in fact, that localization here results from the interpretation of primitive data. But the question is not decided even then, for the defenders of nativism may maintain either that the localization is immediate and the repetition only defines it, or that the operation whereby the impression is referred to the extremities is not interpretation, but mechanism pre-established and inborn; and this is the foundation of their doctrine.

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[1] *Traité des paralysies*, p. 199.

Yet it cannot be denied that if it were established that tactile localization is not immediate, their reasoning would have less weight than that of their adversaries. Is this immediate localization a fact? The first difficulty in replying to this question is to find tactile perception at work alone. Visual perception precedes it. Some hours after birth the child follows the movement of a light a short distance away with its eyes. It begins to feel later. There is reason to believe that the first attempts at tactile localization are greatly assisted by sight. This, in the present case, would afford little support to the nativist theory; for if the child localize contact at a certain point of its body, because it *sees* something special there (for example, a hand or an object approaching), this fact seems to be an interpretation. If we rule out this foreign element, sight, and confine ourselves to tactile perception alone, we are immediately arrested by the lack of observations. Darwin, in his interesting study, *Biographical Sketch of an Infant* (*Mind*, July, 1879), says that the seventh day, when he touched the sole of the child's foot with a piece of paper, "it drew back the foot quickly, and bent the toes under, as an older child does when tickled." But we can see in this only a very vague localization, since the movements of reaction can probably be considered, in this case, only reflex acts. Is localization immediate in some less movable part of the body, as the chest? If so, this would prove the nativist theory; but this has never been established.

The capital defect of this theory is its extreme simplicity. By reducing all to an immediate localized contact, it gives an insufficient role to muscular sensation in the acquisition of the tactile notion. The supposition that each point of our body feels immediately its position in space, for the reason that every sensation is related, by virtue of a law of our organization, to the peripheral extremity of the nerve affected, postulates, really, the point in discussion; for the excitation of a nerve extremity itself affords no data in extension. The empirical theory maintains, on the contrary, that the idea of the position of a certain point of the body (to the right, left, above, below), results only from the play of certain muscles, different in each case, which awake determined muscular sensations in consciousness; in such a way that the directions which call the same muscles into play are the same, that is, the play of different muscles gives different directions.

The empirical theory, then, is characterized by the dominating, almost exclusive role given to movement and muscular sensibility.[1] If it does not surmount all the difficulties, it does take account of all the facts, at least, and deals with the problem in its complexity. It is the spirit of this method to press forward as far as may be in its efforts at explanation, and to attempt the analysis of the simplest elements, instead of assuming extension as an ultimate fact; it reduces the idea to a more general and consequently more simple notion, simultaneousness, and reduces simultaneousness to a notion yet more simple, succession.

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[1] The exposition of this theory does not fall within our province. Bain has developed it most thoroughly. Yet it may be helpful, for clearness of treatment, to point out its distinguishing characteristics. The fundamental proposition is this: The state of consciousness which accompanies certain modes of muscular movement is the original datum of our perceptions of length, height, breadth, form, position, direction, that is, all the determinations of space. If we move one of our limbs freely, we have the feeling of a longer or shorter muscular movement, nothing more. If this movement is arrested at its two limits by an obstacle (as the arrest of the hand by the two sides of a box), the

It is remarkable that in establishing their position, which contradicts absolutely the position of the nativists, empiricists appeal especially to tactile extension; they maintain that touch, and not sight, must be considered, to understand properly the genesis of the notion of space. "The part played by the eye," says Stuart Mill, "in our actual notion of extension, alters its character profoundly, and gives rise principally to the difficulty we find in believing that extension, in its ordinary signification, is a phenome-

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first determination results. In the same way, if we pass the hand or finger over a surface, and say that two points, A and B, are separated by space, we mean, at first, simply that a series of muscular sensations is experienced between the moment that the hand leaves A and the moment that it arrives at B. It is then the sensation of the longer or shorter duration of muscular effort that gives us extension. The notion of length in space is reached from the notion of length in time. What has been said of length is true also of distance, direction, form.

It remains, however, to explain how this series of successive muscular contractions, translated into successive states of consciousness, gives the idea of simultaneousness. Here a second element enters: tactile impressions. In the case cited above, when we pass the hand over a fixed surface, we have, besides sensations of movement, a succession of tactile sensations. Here is the co-existence of two successions. This co-existence becomes still more apparent when we reverse the movement, and cause the tactile series also to be inverted. Further, we easily perceive that the order of tactile sensations does not vary with the rapidity of the movement. If the hand moves more quickly, the series develops more rapidly; if more slowly, *the same series* is reached more slowly. Consequently, the order of tactile sensations may be considered independent of their succession in time and as arranged non, not of synchronism, but of succession." For the man who sees, visual extension is first. Now, by its very nature, sight gives at a single glance a prodigious number of sensations, and thus communicates to its impressions a character of simultaneousness. The peculiar and immediate object of sight is color: sensations of color have grown to be for us representative of the tactile and muscular sensations we would otherwise experience from touching the colored object. The eyes receive in the rough a great number of sensations of color, and the result is the same as if we had received in the rough a great number of tactile and muscular sensations, *i. e.*, the perception of extension. Visual perceptions, as Herbert Spencer has ingeniously said, become symbols of tactile and visual impressions, and play a role analogous to that of formulas in algebra: they replace and simplify.

It would add greatly to the strength of the empirical

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simply one with another. Extension, or space, as far as it is a state of consciousness, has no other origin or meaning; it is simply an association of muscular with tactile (or visual) sensations. "The union of sensations of touch (or sight) with the feeling of the expenditure of motor force explains the whole notion of extension or space" (Bain). Space is thus merely a particular case of simultaneousness. A series of muscular sensations accompanying motion from one object to another, this is the only feature of distinction between simultaneousness in space and the simultaneousness of a taste and a color, or a taste and an odor.

If it be objected that the close association of these two elements—muscular and tactile sensation—does not account entirely for the common conception of space, it may be replied that it is only by a pure metaphysical prejudgment that space is made an independent phantasm. These elements account for all; what remains is imaginary. These elements serve for the explanation, and we have no ground for believing that space or extension is more than that which their composition affords.

For a detailed exposition of this doctrine, see, in particular, Bain, *Senses and Intellect*, 2d ed., p. 111, etc.; Stuart Mill, *Exam. of the Philosophy of Hamilton*, ch. XIII; Wundt, *Physiolog. Psychologie*, p. 480, etc. Wundt accepts the theory only with the additions we have already mentioned, and charges it with the omission of local signs, pp. 495, 496.

position, if extended observations were made on those who are born blind. What we have is neither clear nor sufficient on many points. The most curious, from Platner, a doctor philosopher of last century, brought to light by Hamilton, furnish support to the empirical position. Attentive observation, says Platner, has convinced me that the sense of touch in itself, is utterly insufficient to give us the notion of extension or space; that a blind man considers the world as something active merely, something contradicting his notions of rest; that for him time takes the place of space; that nearness and distance signify only a shorter or longer time, the smaller or greater number of sensations he finds necessary in passing from a given sensation to another. In fact the man who is born blind knows things only as existing, one distinct from another: if parts of his body or objects touched by him did not produce on his sensor nerves different *kinds* of impressions, he would take all external objects for one and the same thing. "In his own body, he did not distinguish his head and foot by their distance, but by the difference in the sensations they caused—a difference which he perceived with incredible delicacy—and especially by means of time."[1] These remarks were made, it is true, previous to the rise of contemporary theories: they bear the date 1785. It is to be desired that other observations be made, and be made with method, expressly to clear up this question. All observation presents a mass of confused details: to see clearly, one must attend exclusively to the object of his search. The debate of the nativists and empiricists has defined the problem but has not solved it; we may hope that new research will give a complete solution.

The considerations which we have been estimating in favor of the empirical hypothesis, rest on a physiological and psychological analysis of tactile perception. There are others to be drawn from pathology, and it seems surprising that so little use has been made of them hitherto. Every one is familiar with the illusions of those who have had limbs amputated; for a long time they seem to have sensations in the arm or leg which has been removed, and these sensations are nicely localized in the fingers and toes.

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[1] For details, see Hamilton, *Lectures on Metaphysics*, &c., II, 174.

Weir Mitchell, in his *Lesions of the Nerves*, says he has seen maimed men who endeavored to extend or bend their fingers or spread them out: they would say, "My hand is open; now it is shut. I am touching my thumb with my little finger," &c. They were convinced that the movement they willed took place, and had a clear idea of the extent and force of this movement. These facts, which have given rise to much discussion, prove, at least, that muscular activity has an important function in perception.

There is another important question. These illusions persist a long time—this can not be doubted; but do they persist permanently? or do they disappear entirely after some years?

Among nativists, Müller alone sees the import of this question, and insists strongly on the negative (Vol. I, p. 643, &c.): "It is generally said that the illusions of the maimed last some time, until the wound has healed and the patient no longer needs a physician. But the truth is these illusions are permanent and preserve the same intensity throughout life.", In support of this assertion he cites nine examples, some of which are in detail.

The contrary is held by many writers.[1] The illusions of the maimed, say they, do not persist, but in time disappear completely.

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[1] Vulpian, *Diction. encycl. des sciences méd.*, art. *Moelle épinière*, p. 533; Carpenter, *Mental Physiology*, p. 150; Spring, *Symptomatologie*, vol. II, p. 82.

What is the bearing of these facts upon the question before us? Evidently the illusion of the maimed, such as arises just after amputation, is at least as easily explained on the empirical hypothesis as by the contrary doctrine. It proves, in fact, the strength of an acquired association. Certain states of the nerves, transmitted to the centres, continue to awake in these centres old associations according to which a feeling of pain or muscular activity is localized in its accustomed place; that is to say, in consequence of habit, a state of consciousness (the initial excitation) awakes a group of consecutive states invariably connected with the first. The nativist theory holds that "each point of the body at which a nerve fibre emerges is represented in the *sensorium* as an integral part of space:" it seems that, in this view, impressions ought to be projected to the actual surface, that is, to the stump of the amputated limb. Really, nativists avail themselves of the fact that, since the sensation arises in the nerve centres at which each point of the surface is represented, it is not surprising that sensations persist permanently in an absent member, for the psychic representation of this member permanently persists.

But admitting this point—though it grants too much to the nativists—it must be proved that this illusion lasts through life: that no habit newly acquired can replace the old state that we are supposing inborn. Müller seems to have seen this when he endeavored to prove that the illusion is permanent. Unhappily for him, the facts seem to contradict his position; and as the final removal of the illusion can be explained only on the supposition that the psychic representations are removed also, it is difficult to see how a capacity that disappears when its conditions are changed can be called innate. In this fact, also, M. Vulpian sees "proof that notions of the position of different points of the skin result from experience and are not facts of graduated innervation. As far as impressions from the stump can replace wholly or in part those that existed before in the skin of the limbs that are lost, these notions persist more or less distinctly. But if these extremities cease to bear impressions to the spinal cord, notions of position are gradually lost."[1]

An analogous case is found in autoplastic operations. When a piece of skin is brought down from the forehead to the trunk of the nose, all contact with its surface is referred by the patient to his forehead, as far as the connection of the nerve fibres between the forehead and nose is maintained. When the connection is cut, new connections are established and the error of localization corrected. The illusion at first may be explained by either hypothesis: for empiricists it amounts to this, that an experience of long standing cannot be immediately modified by new experiences: for nativists, it amounts to this, that every impression is referred by the sensorium to the peripheral extremity of a nerve, whatever be the situation of the extremity. The adjustment later seems explicable only on the empirical hypothesis: according to repeated experiments, impressions of contact become constituent parts of a new group; they enter into relation with new elements and finally constitute with them a stable association. A new localization results from new conditions.

On a comparison of the two theories, the balance of probability seems to be in favor of the genetic. Topographical knowledge of our own body—and this knowledge conditions that of the external world—is the result of repeated effort. Localization is automatic for the adult, but this automatism is not congenital: it must have been acquired. The young child cries when it is in pain, but does not show by any sign that it refers the pain to a particular spot. When we awake with a feeling of uneasiness and discomfort we can not give it immediately a precise local origin. More than half of the facts, ordinary or exceptional, favor the empirical position.

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[1] Vulpian, cited above.

It must be remarked, moreover, that neither of the two theories is exclusive, or can be. Nativists recognize the function of experience, but make it secondary. On the other hand, no empiricist can doubt that there are anatomical and physiological conditions which are inborn and predetermined. Nativists, as their method would lead us to expect, stop too soon in their explanation, innateness being the ultimate fact. Empiricists are indeed free from this fault, but they fail in their allotted task of interpreting all the phenomena in terms of experience. Many points still remain obscure for want of observations both in number and in quality.

III.

VISUAL SPACE.

In visual perception, the same problem arises and in the same form: but here, the conflict between the two theories is more severe, and attempts at solution more numerous. It will not be out of place to speak with some detail. Moreover, the exposition will offer a somewhat dogmatic as well as historical interest, since it seeks to present the question in all its aspects and helps us to enter into its difficulties.

Müller was the first for sight as for touch to maintain the doctrine of nativism from a scientific standpoint. "The retina," says he, "feels its own extension and position, when not in the least affected by the world without. It feels them as darkness before the eyes." This immediate knowledge of its own dimensions serves as the measure of visible objects: it finds in itself its unit of measure. Yet Müller attributes to it only a single inborn property: the perception of *surface* or extension in two dimensions. All that the adult possesses in addition to this original perception is for Müller the result of experience: "The power to know simple forms is not the result of education; but that of judging the different dimensions of body from its image requires exercise, since the visual intuitions are originally of surface only, and since to arrive at the representation of a body, the judgment must add to it the different aspects seen when it is placed in other positions. Thus we reach the representation of depth in the visual field; it is an *idea* and not a sensation." Müller does not admit that the fact that objects are inverted upon the retina contradicts his hypothesis of the intuitive perception of surface. Direct vision does not need explanation because we see everything inverted and not a single object among others; nothing can be inverted when nothing is straight; the two ideas exist only by opposition. Finally, to explain the fact that the two eyes have each its distinct impression and yet perceive a single object in one and the same position, Müller admits that corresponding points of the two retinas have the same perception of space, because at the chiasma, each nerve fibre from the brain divides into two which emerge at identical points: whence results a union of the two impressions in a single perception.[1]

The doctrine of Müller has been called the *hypothesis of subjective identity*. It was early abandoned because it involved too many difficulties, and was contradicted by well-established facts: for example, we see as simple, objects which are not reflected on the same retinal points; this fact alone contradicts the doctrine, and the auxiliary hypotheses of Brücke and others have not explained it.

A second form of the nativist theory has been called the *hypothesis of projection*.[2] It has been maintained by

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[1] *Lehrbuch d. Physiologie*, vol. II, pp. 351–358.

[2] The name was attached to it by Wundt: *Grundzüge*, p. 632. Helmholtz takes it in another sense. See *Physiolog. Optik*, p. 442.

Tourtual (1827), Volkmann (1836), admitted in part by Donders and Nagel (1861). According to this hypothesis the retina is capable of projecting its impressions outward, in given lines of direction or of sight.[1] These writers insist upon an immediate projection; while, according to Müller, objects are not projected in external space, but are referred for special determination to extension within. As has been remarked, this hypothesis is implicitly admitted in most physiological research. Impressions are generally considered as projected into space along the lines of vision. On the hypothesis of projection, it is not difficult to explain the fact that impressions at points which are not identical in the two retinas give a simple perception. On the other hand, it does not explain the double images of binocular vision. If, in fact, images are projected along the lines of direction or sight, we ought to see everything simple, since the rays that belong to a luminous point cut each other at that point. Yet Donders maintains that this hypothesis explains the majority of cases.

The theories of which we have spoken have been variously modified—the last especially—in view of the explanation of new facts. Nagel, among others, in his book on binocular vision (*Das Sehen mit zwei Augen*, &c.), has contributed to it.[2] Independently of the difficulties we have dimension); 2d. A "binocular energy for the combination of colors," by which colors seen with two eyes combine and are seen as one; 3d. A "binocular synergy of alternation," by means of which colors seen with two eyes may be kept distinct. As a critic has remarked,[1] Panum enriches the retina with so many inborn powers that he may be called the most logical and courageous representative of the nativist hypothesis.

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[1] It may be of service to define the terms used in the exposition:

Identical (Müller) or *corresponding* (a term more used in our day) points in the two retinas, are upon corresponding horizontal and vertical meridians. Points that do not correspond are called *disparates*.

Lines of direction pass from luminous points in the retinal image through the nodal point of the eye. *Lines of sight* pass through the centre of the retina, the centre of the pupillary image, and a point in space. By tracing lines of direction, we obtain the retinal image of an object; but these lines do not coincide with those by which we project the retinal image without. In fact this projection is in the direction in which we see. For more details see books on Physiology.

[2] Nagel supposes that the two retinal images are projected on the different spherical surfaces which have as centres the point of inter-

His theory served as basis for that of Hering, who, it is agreed, gave to nativism its profoundest and most logical form, in his *Beiträge zur Physiologie* (1861–1864). Hering attributes to the different points of the retina feelings of extension (*Raumgefühle*) of three kinds: length, breadth, thickness. Each point has its own value in breadth and length; this value increases in proportion as it is distant from the centre of the retina, and points situated on the right and left, above and below the centre of the retina have opposite values. By means of these feelings, the retina arranges its impressions in two directions. The third feeling, giving depth, is of a particular nature: it must have, says Hering, equal values, but contrary signs, for *identical* retinal points; equal values and the same sign for *symmetrical* points. The feeling of depth of the two outer halves of the two retinas is positive: it answers to greater depth. That of the inner halves is negative, and answers to lesser depth. Since identical points (that is, points having the same latitude and longitude) have, as has been said, feelings of depth of equal value, but of opposite sign, it results that for these points the perception of depth is 0. These points seem to form a plain which is the principal

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the *Archiv Reichert*, 1861. The angle in which an object is seen from a given distance is called the parallax. In binocular vision, two points not symmetrically situated in reference to the observer's median line, form parallaxes differing more or less for the two eyes.

[1] James Sully, *Mind*, No. X, p. 171.

surface of the visual field (*Kernfläche des Sehraumes*). At first, the distance of this surface seems undetermined: it is neither near nor far. It is only by experience that the observer assigns position to it in reference to himself. Our body, since it is always in the field of vision, serves as point of departure in determining the distance. Impressions on the outer halves of the two retinas are placed beyond this principal surface; impressions on the inner halves, within. The entire impression resulting from the binocular fusion of the two impressions takes the mean value of the feelings of length, breadth, and thickness.

The theory of Hering has one merit at least: it is logical. The perception of the third dimension, as well as of the other two, is deduced from capacities innate in the retina. Hering allows to experience only what every intuitive hypothesis must; he denies entirely the function of muscular sensation.

In the book already cited, *Ueber den psychologischen Ursprung der Raumvorstellung*, 1873, Stumpf, in the general characteristics of his theory, can be called a nativist. Although he does not hesitate to criticise his predecessors, and believes that he can reconcile the two theories, still in reality he gives to intuition the leading place. His theory is not presented in systematic form, as those of which we have already spoken. He is not a physiologist, moreover: his principal object is to examine the psychological value of the different solutions, and exhibit their strength or weakness. His book, the work of a skilled reasoner, includes as well the solutions of the Scottish school (Hamilton, Mill, Bain), as those of his countrymen. His fundamental principle is that "the notion of space rests in its elements upon sensation, and in its development upon association." He is driven to maintain that extension and its content (light, color, etc.) are inseparable, and consequently, with the first sensation of light or color, the notion of space of two dimensions is given. Thus it becomes intuitive, although external excitation is the occasional cause.[1] In regard to the third dimension, Stumpf reasons the same for sight as for touch; a few words will suffice to characterize it. Surface extension is given immediately in sight; now every surface is either plane or curved. These two species imply the third dimension, for they imply the presence or absence of an inclination outwards toward depth.

These are the principal forms of the nativist theory. They are as complex and scientific as those we have mentioned on touch, but in a different way. Yet, as Helmholtz justly remarks, their fundamental characteristic is always the same; *i. e.*, "they make the localization of impressions in the field of vision innate, whether it be that the soul has direct knowledge of the dimensions of the retina, or that the excitation of given nerve fibres gives rise to representations of space by means of a pre-arranged mechanism that cannot be understood more precisely." It remains to consider the empiricists in their turn.

Although we are dealing with German thinkers, we must mention Berkeley as the first systematic representative of empiricism. The debate had not begun in his time, but his position is clear notwithstanding. In his first work, published in 1709 (*An Essay toward a new Theory of Vision*), he maintained that the peculiar and exclusive object of sight is color; that visual sensations are arbitrary signs suggesting to the mind the idea of externality. In his other works he also took this position. "We perceive distance not immediately, but by mediation of a sign which hath no likeness to it, or necessary connection with it, but only suggests it, *from repeated experiences*, as words do things.[1] Finally, he considers tactile sensation an indispensable auxiliary to visual sensation, a point common to most of the empirical theories.

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[1] Ueberhorst, in his book *Die Entstehung der Gesichtswahrnehmung* (Göttingen, 1876), has shown the importance of the position that sensations of color can not have originally any determination as to space.

Yet the position of Berkeley is connected with the more general doctrine of "immaterialism." Steinbuch, a writer already mentioned in connection with touch, put the question in an experimental form. Movement alone, said he, can give us the notion of space. The retina has no power of perceiving relations of contiguity or position among its parts; this perception is due to movement of the muscles of the eye. An illuminated point of the retina becomes a luminous line by the conscious contraction of a muscle, and this contraction has degrees for different parts of the retina. Thus, by the contractions necessary to expose different parts of the retina in turn to the same rays, difference of space in the retina becomes difference of time. Each point of the retina has its degree of muscular contraction; and it results that, as the result of education, the luminous sensations at particular points are tacitly connected in consciousness with the degrees of contraction that belong to these points. Müller, after explaining this theory, remarks "that, if points in the retina are not different in nature, we have no means of knowing them as distinct, and that, without a qualitative difference in the sensation, it is impossible for any *quantum* of contraction to unite, in memory, with a point of the retina" (II, 540). This remark is just; and it can be further said that the hypothesis of Steinbuch suggested the theory of local signs, i. e., of a peculiar characteristic for each point of the retina.

As we have seen, this hypothesis of local signs was developed by Lotze. His theory has been already treated at length. Yet it must be added that he has had a great influence in the way of reaction in favor of the experimental position and against the nativist, which, before him, was blindly accepted by physiologists.

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[1] *Alciphron, or the Minute Philosophers*, 4th Dialogue (II, p. 148–Tr.).

Wundt, in his Memoirs, published 1858 to 1862 in the *Zeitschrift für rationelle Medicin*, was the first to show in a manner at all complete that the formation of the field of vision can be sufficiently explained by means of two classes of data: local differences of sensation in the retina, and movements of the eye. He has studied the latter element carefully, and deduced the estimation of distance in the field of vision, from the conscious muscular effort necessary to sweep the field with the eye. He maintains that for sight as for touch the notion of space cannot result from the simple association of the two primitive elements (retinal impression and movement); it can result only from *synthesis*, a combination of such a nature that the result shall differ from either of the two elements.[1]

The leading representative of the empirical position is Helmholtz. Not to speak of his important work as a scientist, he has given in his *Physiologische Optik* and *Populäre wissenschaftliche Vorträge* a very elaborate psychological theory of the genesis of visual space from experience alone. Two physiological elements serve as basis for his explanation: 1st. Signs furnished by sight. They are distinguished from one another by three characteristics: intensity, quality (color), locality, the last depending upon the portion of the retina excited. 2d. The degree of innervation felt by us and referred to the nerves of the muscles of the eye. These elements serve as basis for the higher mental operations by which the notion of space of three dimensions is afforded.

Helmholtz's fundamental position, as we have already latter cannot, in that it is made up not of words, but of sensations and the memory of sensations."[1] If these processes were translated into the analytical terms of formal logic, they would seem to be *inductions*. They would really have, as a starting point, propositions established by experience, that is, as Stuart Mill remarks, a register of facts, gathered into a simple formula, which, although adding nothing to our knowledge, is of great practical importance, since it gives a conclusion for all cases in which the data are the same. An example will make this clearer. When we feel an impression on the right side of the two retinas, we know from experience repeated in many cases that there is a luminous body at our left. We have ascertained that the hand must be stretched out to the left to hide or seize the light, and that we must go to the left to approach it. If, in cases of this kind, we do not reason consciously, we have none the less the essentials of ratiocination and have reached a conclusion: the work has been done by unconscious processes of association of ideas residing in unexplored parts of the memory.[2]

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[1] For a detailed exposition of Wundt's theory, see the chapter devoted to him, § III.

To sum up, the operation, as Helmholtz conceives it, is this: every impression on a given part of the retina produces, by means of local signs and muscular movement, a given modification of the sensorium (first group of facts). By the aid of touch, movements of the body, and various experimental contrivances, we determine the cause of this modification (second group of facts). These two groups of facts, when repeated a sufficient number of times, become so closely associated, that, when I press my eye to the right, I invariably see a light to the left, and only objective verification teaches me that it is an illusion, and that the second group of facts is wrongly deduced. Our knowledge of the said, is this, that sensations are signs to be interpreted. Our representations are necessarily symbols of objects only: we learn to use them to regulate our movements and actions. "When we have learned to interpret these symbols correctly, we are able with them to direct our actions to the result desired, that is, to bring about new sensations." The truth of our representations, then, is *entirely practical* in its nature, and to ask whether they are true to their objects is nonsense; and "the search of nativists for a pre-existing harmony between the laws of thought and the laws of nature rests upon a misconception." Yet these signs, given us for interpretation, appear as *effects* of which objects are the causes. We believe this, because repeated experiment upon objects has shown that the modification of our sensations rests in part in the will, but is imposed upon us partly also from without, independently of all internal action. "Thus we come to recognize in sensation a cause independent of our will and imagination, *i. e.*, an external cause;" and thus the idea of cause is introduced as a regulating principle in the order of perception.

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[1] *Populäre wissenschaftliche Vorträge*, III.

[2] *Physiolog. Optik*, p. 449. French trans., p. 586.

This admitted, the psychological mechanism by means of which we form a representation of space, or to speak more correctly, by means of which we look upon an object as extended, that is, as having such a form, position, direction in the field of vision, etc., can only be a process "of unconscious reasoning." If this expression, says Helmholtz, is objected to it is because we are accustomed to consider reasoning the highest form of intellectual activity. But the processes of reasoning of which we now speak, although they can never be put in logical form, are identical with our ordinary processes—a mental operation and product. "The difference between the reasoning of logicians and the unconscious reasoning upon which our knowledge of the external world rests seems to me very plainly to consist in this: that the former can be formulated, and the latter cannot, in that it is made up not of words, but of sensations and the memory of sensations."[1] If these processes were translated into the analytical terms of formal logic, they would seem to be *inductions*. They would really have, as a starting point, propositions established by experience, that is, as Stuart Mill remarks, a register of facts, gathered into a simple formula, which, although adding nothing to our knowledge, is of great practical importance, since it gives a conclusion for all cases in which the data are the same. An example will make this clearer. When we feel an impression on the right side of the two retinas, we know from experience repeated in many cases that there is a luminous body at our left. We have ascertained that the hand must be stretched out to the left to hide or seize the light, and that we must go to the left to approach it. If, in cases of this kind, we do not reason consciously, we have none the less the essentials of ratiocination and have reached a conclusion: the work has been done by unconscious processes of association of ideas residing in unexplored parts of the memory.[2]

To sum up, the operation, as Helmholtz conceives it, is this: every impression on a given part of the retina produces, by means of local signs and muscular movement, a given modification of the sensorium (first group of facts). By the aid of touch, movements of the body, and various experimental contrivances, we determine the cause of this modification (second group of facts). These two groups of facts, when repeated a sufficient number of times, become so closely associated, that, when I press my eye to the right, I invariably see a light to the left, and only objective verification teaches me that it is an illusion, and that the second group of facts is wrongly deduced. Our knowledge of the field of vision, which consists of a sum of representations, is acquired, then, only when each excited point of the retina has become capable of associating to itself a group of corresponding facts. It is evident that Helmholtz meant under the name unconscious reasoning what the Scottish school call "inseparable association." And he expresses himself exactly as Mill or Bain, when he says: "The only psychic act necessary to this result is the regular repetition of the association of two representations that are once associated, and this association has more force and necessity according as it occurs oftener."[1]

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[1] *Populäre wissenschaftliche Vorträge*, III.

[2] *Physiolog. Optik*, p. 440. French trans., p. 586.

Such are the general principles of the theory of Helmholtz. We will briefly indicate some details. Our knowledge of extension of two dimensions from monocular vision is reached by means of movement. The author presents no hypothesis either as to the nature or anatomical disposition of the local signs. He admits that these signs may be scattered at random upon the retina: this would not change his theory at all; except that the habitual association would be more difficult. It is by means of movement that the eye learns the order of the points of the field of vision, that is, the local signs that belong to points in immediate proximity to one another. This relates the localization of impressions to certain other impressions which are connected in a definite way with the excitation of certain fibres. As for the third dimension, we have already seen how Helmholtz explains the notion of distance and externality. The binocular perception of relief rests entirely upon the fact that we are simultaneously conscious of two different images. The *sensations* of the two retinas are perfectly distinct from each other: they arrive in consciousness without fusion. They are combined in a simple *representation*, when in consequence of repeated association, they become signs of one and the same object. "Their fusion into a single notion of the external object is not accomplished by a pre-arranged mechanism (as the nativists maintain), but by a psychic act."

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[1] *Physiolog. Optik*, p. 798. French trans., p. 1002.

Such are the principal forms of the empirical theory. Wundt makes of them two classes: 1st. *Logical* theories, which are of two kinds; the one, as Berkeley and the first representatives of empiricism, holds that notions of extension are the result of a conscious reasoning process; the other introduces an unconscious activity; 2d. *Association* theories, whose principal representatives are in England. This classification is not exhaustive, since Helmholtz does not belong to either class.[1]

We have already compared the two rival theories on the subject of touch, and indicated, in a general way, the merits and defects of each. We will now confine ourselves to the special question of visual space. And this must be viewed only in its psychological aspect. Intuitionism and empiricism do not propose simply to give a metaphysical explanation of the notion in the abstract; they must interpret experience also, and give an account of the varied phenomena of visual perception. These physiological problems have been discussed by men skilled in experiment, who have devoted years to such investigations; we have named them already. Their results, even in questions of fact, do not agree. Although the empirical theory suffices to explain the majority of cases, and offers the greater probability, yet it is not established, and many of its experiments are disputed. It is not strange that the discussion is not yet closed upon a question that is so delicate from a psychological standpoint and involves a critique of the fundamental notions of the intelligence.

What is the peculiar object of sight? This very simple question sums up the debate. If we reply: Color, we a empiricists. If we reply: Colored extension, we cast ou lot with the nativists.

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[1] Wundt gives his own theory the name "synthetic."

One of the merits of Stumpf is that he sees that th whole question lies in germ here, and had he proved tha color and extension are inseparable, nativism had won th day. Before him, Hamilton employed the resources of hi subtle dialectic to show by reasoning alone that distinctio of color necessarily implies distinctive determination i extension; but the reply which Stuart Mill made to hir seems to us final.[1] We refer the reader to it.

It will be remarked that the theory of local sign although developed especially by the empiricists, is reall common to the two schools. The perception of local differ ences in the field of vision is a fact, and it can be explaine only on the hypothesis of local signs. But when it come to a determination of their nature, the two schools differ.

According to the empirical theory they are any distin guishing signs whatever: only that their significance rela tive to the perception of the external world is the result o experience. It is useless to suppose any agreement furthe than this, between the local signs and the local difference that correspond to them.[2]

According to the nativist theory, on the contrary they give an immediate notion of local differences, of thei nature, magnitude, and relative position: being at onc organs of sense and elements of space. From a philo sophical point of view, as Helmholtz has remarked, thi theory supposes a pre-established harmony between though and the laws of nature.

The nature of the local signs, then, is not a point o which either of the two schools can be profitably attacked since each presents, in its own way, a plausible explanation.

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[1] *Exam. of the Philos. of Hamilton*, p. 277.

[2] Helmholtz, *Populär. wissenschaft. Vorträge*, III.

Pursuing our comparison to the question of visual space considered as simple surface, we find that the two theories are about equally credible. There are still, however, for the nativist hypothesis, some points of stumbling.

1st. The inverted position of the retinal image presents no difficulty on the empirical hypothesis; this image is simply a matter for mental elaboration, a datum for experience to interpret; its position is a matter of secondary importance. But not so to the nativists. This fact has embarrassed Müller and others; they have derived it only by involved and inadmissible explanations.[1]

2d. Despite the intervention of retinal images, we see simple in the majority of cases. In fact, nativists maintain that impressions received at corresponding or identical points give simple vision; and impressions at disparate points, double vision. But Helmholtz has shown that images at corresponding points sometimes give double vision, and, *vice versa*, images at disparate points sometimes become fused.

When we pass from the notion of surface or two-dimentioned space, to cases in which the third dimension enters, the debate is very warm. It is on this field, over the solution of this problem, that the great battle between the two schools has been joined. We may say that empiricism has gained from day to day, while most of the discoveries have brought new embarrassment to the nativists. We have seen in the earlier exposition that the empirical explanation is simple, that it is based on physiological and psychological facts, that it invents no faculties and avoids all useless hypotheses. Nothing, on the contrary, can exceed the complexity of the theories of the nativists. We may give to the retina an innate perception of its extension, with Müller, or clothe it, with Panum, in the attire of intuitive cognition; we may suppose, with Hering, a principal surface of the field of vision, undetermined as to its distance from the eye; all these hypotheses have one disturbing characteristic: they are invented simply to explain the facts; they are the work of the imagination, not scientific solutions. In any case it is wrong to have recourse to them, if there are facts and known laws sufficient to solve the problem. Besides there are other data which we can not deal with here (the perception of relief, lustre, &c.), which may easily be explained on the empirical hypothesis, but are very embarrassing on a theory of predisposed mechanism. And pathological facts may be cited against such predisposition: for example, in the case of paralysis of the abductor muscle of the eye, the patient sees objects further from him than they really are. The distance seems too long because the muscular contraction must be greater to execute the same movement. The patient grasps space only when he expects to take the object. A stone-mason afflicted with this disease, struck his hand with the hammer, instead of hitting the stone (Wundt). But little by little the disease accommodated itself to his movements, though it cost him the greatest effort in the part affected. This successive accommodation of pathological states throws light on the way in which a derivation often passes for an original. If, when the conditions are changed we can come to estimate anew the position of an object, it seems natural to say that originally the idea of direction arose from a relation between the muscular sensation and the point in the retina which experienced the external excitation. Still other arguments are found in certain cases of squinting;[1] but, not to insist further upon it, this is the chain of facts that inclines us necessarily toward the empirical theory. We borrow from Helmholtz the *résumé* of reasons which lead us to conclude in its favor:

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[1] Fick, for example, supposes that the nerve fibers, at their entrance to the brain, establish impressions of above and below, right and left, as they really are—an hypothesis which has no anatomical foundation.

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[1] See on this point Helmholtz, *Physiol. Optik*, French trans., p. 882.

1st. The theory of nativism seems to introduce an unnecessary hypothesis.

2d. Its results give, in accounting for space, notions that rarely accord with fact. The advocates of this theory are obliged to admit against themselves that their original *sensations of space* may be modified, or, indeed, replaced by knowledge furnished in experience.

3d. It is hard to see that these original *sensations of space* can contribute anything to the explanation of visual perception, since the advocates of this theory are compelled to admit that, in the great majority of cases, these sensations must be supplemented by very profound experiential knowledge. If this is necessary, it seems simpler and easier to admit that all notions of space are furnished by experience only, without having first to combat innate notions which are false in most cases.[1]

It remains to estimate some considerations against the empirical theory which cannot be passed over in silence.

The first of these objections rests on a well-known fact. Bailey, in England, first used it in his attack on Berkeley's doctrine of sight, and it has been renewed later by other nativists.[2] The chicken just hatched, still carrying a fragment of the shell upon its tail, catches a fly on the wing. The little calf makes the necessary movements to suck its mother. The crocodile, hatched with no parental incubation, starts directly for the water, bites a stick that is held out to him, etc. We cannot deny that these facts, though they may be modified by the name instinct—which explains nothing—favor the nativist theory, since they show that animals, "as soon as they see the light, see depth also."

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[1] Helmholtz, *Physiol. Optik*, p. 442; French trans., p. 578.

[2] Stumpf, work cited, p. 296. The best collection of facts of this kind is to be found in Abbott, *Sight and Touch*, p. 178, etc.

Helmholtz, who has discussed this objection (in his *Pop. wissenschaft. Vorträge*, 2d series), replies: "It is said that the calf sees the udder of the cow and seeks for it. It is a question whether it does not smell it merely, and make movements in the direction of the odor. The chick picks about to find grains; but it has picked in the shell before, and seems to pick at first at haphazard, as it follows the example of the hen. After it has found some grains by chance, it learns their appearance; and this it must learn the more quickly as its life is so extremely short."—"It would be desirable that new observations be made in this connection, especially to throw light upon this question. Observations made hitherto seem to me to prove no more than that animals have at birth certain *tendencies*; and it is certain that in the case of man these native tendencies are reduced to very few."

The second objection is based upon theoretical considerations. It was formulated by Wundt, though he rejects the intuition hypothesis notwithstanding. The genesis of our ideas of space is referred by Helmholtz to processes of reasoning from analogy. Thus, according to him, we place on the right in space impressions that affect the retina on the left; because, in a great number of previous cases, experience has taught us that the object is really in that direction. But, objects Wundt,[1] this reasoning from analogy does not apply to primitive experiences, to those which are first in order, and serve as basis for all the rest. In truth, Helmholtz escapes this objection by maintaining that primitive representations of space are formed by means of touch, agreeing in this with the founders of the empirical theory, Berkeley and Condillac. Still the objection is only removed further back, as the same difficulty arises in the case of touch. Helmholtz admits, in the law of causality, an element that is not given in pure experience, and which does not help the explanation of primitive notions. Wundt also has recourse to the synthetic theory, of which we have already spoken.

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[1] *Grundzüge*, pp. 638–640.

We now have an impartial statement of the question. We must say that these objections are not without weight; otherwise, the victory of the empirical theory would be complete, and the rival position would belong to history only. Whatever opinion we adopt, the debate affords a fine example of analysis applied to a notion which has passed as simple and ultimate, and this analysis is not merely verbal and ideological after the manner of eighteenth century discussions; but conducted, as far as possible, with the help of objective observation and experiment. Beside the experimental difficulties that impede the physiologist at every step, there is a psychological difficulty throughout the whole debate. At first sight, it seems very easy to say: this is primitive, this is acquired, this is a fact, this is an induction. Yet the reader has seen how difficult it is to be sure in such cases. The perception of distinct color, red, green, seems to be an act of immediate cognition, with no possible error when the eye is normal. Yet the facts of *simultaneous contrast* (modifications which the colors undergo when placed in juxtaposition) seem to show that there is here a cerebral process more complex than simple perception—and this is the beginning of an interpretation.[1] How much more difficult is it to separate sensation and inference in cases so complex!

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[1] Helmholtz, *Optik*, § XXIV, in particular, p. 543. Yet it must be remarked that Hering, and other more recent writers with him, believe that they have explained different optical phenomena, especially simultaneous and successive contrasts, consecutive images, etc., by a purely

We will add, in closing, that it would be wrong to attribute to either of the two schools an invariable philosophical tendency. In fact, nativism is as likely to be materialistic as idealistic. In the former case, the innateness of space is referred to the anatomical constitution of the organs only: in the latter, the idea of space is considered innate in consciousness. In the same way, empiricism may maintain that impressions are signs of things, interpreted according to our earlier experience; or, with Helmholtz, it may admit a regulative principle, as causality. Nativism supposes a pre-established harmony between the laws of thought and the laws of the external world. Empiricism seeks to deduce from experience the agreement that exists between the external world and our ideas.

It is evident also that Kant's doctrine of space and the theories we have discussed deal with problems of an entirely different order. Whether we consider space an *a priori* form of mind, or an objective reality, or an abstraction, the question of its genesis in the human mind remains unanswered. So nativists have no right to make use of the name of Kant. In the words of this philosopher, they confound a question of the phenomenal order with a problem of the transcendent order, the ultimate origin of the notion of space. The discussions of which we are speaking cannot depart from facts and their immediate interpretation: this is the point we wish to emphasize.[1]

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physiological process, i. e., assimilation and dissimilation of matter in the visual substance. Hering's work has been published in the *Reports of the Academy of Sciences of Vienna*, 1872–1874.

[1] A very complete exposition of the nativist and genetic theories is to be found in the work of Cesca: *Le teorie nativistiche e genetiche della localizzazione spaziale*, 1882 (Drucker et Tedeschi, Verone, Padoue). The author has classified and explained them with method, comprising, as we have not been able to do here, the theories of Spencer, Bain, Taine, Delbœuf, etc.

CHAPTER V.

FECHNER AND PSYCHOPHYSICS.

I.

(In the domain of experimental psychology, few men have published researches as original and as warmly debated as Gustav Theodor Fechner, now honorary professor in the University of Leipzig. From the year 1836, the date of his first work, *The Life after Death*, to the last months of 1877, the date of his last book, *In Sachen der Psychophysik*, Fechner has touched upon all the philosophical problems, and has taken part in all the great discussions that they have raised in Germany. The list of his works shows it: they comprise metaphysics, morals, religious questions, the doctrine of evolution, æsthetics.[1])We find here a great number of new thoughts and enticing hypotheses. In æsthetics especially, or at least in the study of its physical and physiological conditions, Fechner has shown a rigor of method very rare among German æstheticians. But it is not our object to examine these different publications: the true glory of Fechner is elsewhere; in his work in psychophysics. In 1860 the *Elemente der Psychophysik*[1] appeared, a large book, full of experiments, tables, figures, calculations and philosophical generalizations. This work has served as basis for all the debates which have arisen for twenty years. Fechner has replied to his critics only incidentally in memoirs or articles.[2] Taking the offensive again in 1877, in his *In Sachen der Psychophysik*, he met all his critics and maintained his first conclusions against them. If psychophysics endure under one form or another, it will be his work, and he can be called its founder, although he has always refused this title and in his historical *résumé* of the question (*Elemente der Psychophysik*, book II, pp. 548–560), gives the honor especially to Weber. We will speak later of Weber's work. It is certain that before Fechner there existed only fragmentary works without general range: he was the first to publish a complete and systematic book. It is against him, therefore, that all attacks have been directed.

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[1] *Das Büchlein vom Leben nach dem Tode*, 1836. *Ueber das höchste Gut*, 1846. *Nanna oder über das Seelenleben der Pflanzen*, 1848. *Zendavesta oder über die Dinge des Himmels u. des Jenseits*, 1851. *Die physikalische u. philosophische Atomenlehre*, 1855. *Ueber die Seelenfrage*, 1861. *Die drei Motive und Gründe des Glaubens*, 1863. *Einige Ideen zur Schöpfungs- u. Entwickelungsgeschichte der Organismen*, 1874. *Vorschule der Æsthetik*, 1876, etc., etc. To these works those which treat of psychophysics must be added.

In the account which we will give of this question, we propose, after having shown in some words the object of psychophysics, to explain the experiments on which it is based, and the law which has been adduced from them; finally to state the objections which it has encountered.

"I understand," says Fechner, "by psychophysics, an exact theory of the relations of soul and body and, in a general way, of the physical world and the psychical world." The sciences of nature, long since in possession of their principles and method are upon a road of continuous progress. On the other hand, the sciences of spirit—psychology and logic at least, have also had their foundations in a measure laid. On the contrary, the science of the reciprocal relations of body and spirit is far less advanced than the two groups of sciences just named, between which it occupies an intermediate position. So far it consists only of theories without proof, or a collection of facts without precision and order. Fechner's object is to inaugurate a positive era in this kind of research, or more exactly to build up a science resting upon experiment, calculation, and measure.

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[1] Two volumes in 8vo: Leipzig, Breitkopf u. Härtel.

[2] Memoir against Aubert in *Berichte der Sachs. Societät*, 1864. Article against Delboeuf, *Jen. Literat. Zeitung*, 1874, No. 28.

In principle it places the new science outside of all metaphysical hypothesis. This fact deserves mention the more because, in the various works of which we have given a list, Fechner is far from being guarded in this respect and the boldness of his theories sometimes resembles pure fancy. We find in him a mixture of Berkeley and Leibnitz, together with adventurous hypotheses on the nature of atoms, the soul of the stars and of the universe. All this is outside our subject, and whatever conception of the world Fechner has elsewhere presented, nothing of it appears in his *Psychophysica*. "Our investigations," he says, "pertain only to the phenomenal side of the physical world and the psychical world, that is, to what is immediately given in internal and external perception, and as much as can be concluded from phenomena—in short, we study the physical as physics and chemistry present it; we study the psychical as experimental psychology (*Erfahrungsseelenlehre*)[1] gives it, without investigating, behind the phenomena, the essence of soul and body, as metaphysic exhibits it."

In the preliminary portions of his book, the only general idea that Fechner has thrown out on the relation of the physical and mental is that the opposition between body and mind arises from a difference in point of view only; what, in fact, is one, appears double. "What from an internal point of view seems to be your spirit, the spirit that is yourself, seems, from an external point of view to be the bodily substratum of that spirit. That is, all the difference consists in thinking with the brain or considering it the brain of a thinking being." In nature, nothing more frequently occurs than that opposition which seems at first sight real, disappears when we consider it under another aspect. If we stand at the centre of a circle, the convex is hidden from us by the concave side; if we place ourselves without, the concave is hidden by the convex side. These two sides of the circle are as inseparable as the two sides of man (spiritual and physical), and it is equally impossible, in the two cases, to perceive the two at once as long as we remain in the same position. Similarly, our planetary system, seen from the sun, then from the earth, presents an entirely different aspect. On the one hand, the Copernican system; on the other, the Ptolemaic. It is impossible for any observer to see these two aspects at once, although they are necessarily connected with each other. There are in nature many other cases of this kind, and to Fechner the difference between the physical and psychical is one of them.[1]

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[1] Better translated, *empirical psychology*.—Tr.

It is hardly necessary to remark that this position is not at all paradoxical; that it has been held by eminent scientists, and that it can have no direct influence on psycho-physical research. Moreover, adds Fechner, the object of my work is not to treat of this fundamental question; let each solve the enigma as he please; it is of no consequence to the work that follows.

A single point, whose importance we will appreciate further on, in the metaphysic of Fechner, breaks in upon his investigations, i. e. his hypothesis of *psycho-physical movement*. It would be useless to speak here of a theory which will be made intelligible in the course of our exposition. We will only say that, while, if we hold to the simple data of experiment, the fact of transmission only by the nerves and nerve centres between the excitation produced by an external object and the sensation which results from it, is given, Fechner intercalates between these two terms a *psycho-physical movement* in order to explain the disproportion between the cause (excitation) and the effect (sensation); and that this hypothesis has given rise to the most serious criticism.

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[1] *Elemente der Psychophysik*, Introduction.

We must also bear in mind that, although Fechner pretends to give a general theory of the relations of the physical and mental, his experimental research bears definitely upon a single point alone: the relation of excitation and sensation. It is true that under the name of "internal psychophysics," he includes a series of studies on the seat of the soul, wakefulness and sleep, attention, reminiscence, &c., &c.; but these studies are far from having the exact character that psychophysics requires. So we may say that Fechner has concentrated all his efforts, as his opponents all their criticisms, upon a single question. The question of sensation is, after all, capital, since from it all else comes, and this would be sufficient reason to Fechner for digging to the foundation. Let us see, then, wherein his work and its value consist.

II.

PSYCHO-PHYSICAL RESEARCH.

Fechner's principal object is to measure sensation. To accomplish this he has given long years to experiment and calculation. He has found, besides, in different memoirs on mathematics, physics, astronomy, physiology, by Euler, Bernoulli, Laplace, Bouvier, Arago, Masson, Poisson, Steinheil, &c., scattered observations, made with a different end in view or left before without psychological interpretation. He has met these results with his own.

The way was opened for him, however, by E. H. Weber. Weber (in his *Programm. collect.*, and his celebrated articles in Wagner's *Handwört'r'b. der Physiol.*) deduced a law from certain experiments on the perception of weight, length, &c. (He had remarked that, if we compare two lines almost equal, the smallest perceptible difference is equal always to about $\frac{1}{50}$ of the shorter, whatever be the length of the lines compared, whether a centimeter, decimeter, or meter. In the same manner, in order that a weight be judged greater than another, it must exceed it by a fraction varying from $\frac{1}{30}$ to $\frac{1}{40}$, according to the individual, whatever be the initial weight (gram, ounce, pound, kilogram). Weber added to these results an analogous fact in acoustics: between two tones of different pitch, the smallest perceptible difference is always the same, whatever be the pitch of the tones, and this smallest difference is always the same fraction of the lower tone. These experiments, resting in three distinct orders of sensation, led Weber to formulate this law: sensation grows with equal increments when the excitation grows with *relatively* equal increments.[1]) This law has been stated by M. Delbœuf in another form: "The smallest perceptible difference between two excitations of the same nature is always due to a real difference which grows proportionally to the excitations themselves."

Such was the state of the question before Fechner. In order to understand well the course of the investigations into which we are about to enter, it is well to remark that physiology distinguishes in our sensations taken in general, two things: their quality, and their intensity or quantity. Although it may well be possible in their last analysis to reduce these two to one, they are still, in fact, at least, given to us distinct. Thus, in the category of visual sensation, red, blue, green, are given as qualities. But these sensations, remaining the same in quality, may vary in intensity: they increase or diminish. Every sensation has, then, a quantitative value. Moreover, the simplest reflection teaches us the same; there is no one who has not compared two sensations, and ascertained that they are equal or unequal, that one is greater or less than the other. We assert without hesitation that it is brighter at midday than by moonlight, that the firing of a cannon makes more noise than the firing of a pistol. There is, then, a quantitative comparison of sensations; but we can only say there is equality or inequality; never *how many times* one sensation is greater or less than another. Has the sun a hundred or a thousand times more brilliancy than the moon? Does a cannon make a hundred or a thousand times more noise than a pistol? It is impossible to answer this question. The natural measure of sensation that each man possesses reveals to him the more, the less, the equal, never the *quantum*. Our determinations are always vague and approximate.

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[1] This law may be made clear by an example: a sensation of weight grows with equal increments, if to the original excitation, say 3 grams, we add $\frac{1}{3}$ of 3 grams = 1 gr., if to this second excitation, 4 gr. we add $\frac{1}{3}$ of 4 gr. = $\frac{4}{3}$ gr. and so on. The excitation, as we see, grows with increments relatively but not absolutely equal. On the difference between the law of Weber and that of Fechner, given later, see the paragraph devoted to criticisms.

Even so, although we may say in a general way that the intensity of a sensation increases or decreases with the intensity of the excitation that causes it, yet we cannot determine this relation exactly, or know whether the sensation increases directly as the excitation, more slowly, or faster: in a word, we know nothing of the law that rules the relation of cause to effect here. We do not know whether an excitation of an intensity 1 causes a sensation of an intensity 1; whether an excitation of an intensity 2 causes a sensation of an intensity 2, or 3, or 4, etc.

At first view, every attempt to measure the degree of sensation exactly may appear very hazardous, for sensation has no exact measure in itself. But upon reflection we see that, while in every measure a standard is necessary, this standard can never be the object measured; that we measure things only by an artifice. Now this artifice is afforded us in this case by the nature of the phenomena. In fact, we know very well that every sensation is a neural phenomenon, and we know also that neural phenomena depend upon an external movement which we call excitation. To vary the excitation is, through the nerve medium, to vary the sensation; the nerve force being the *proximate* cause of the sensation, and the external excitation the *remote* cause. But since we hold this external cause—the excitation—under our control, and since it is open to the most exact measurement, it seems that through it we can measure the sensation itself.

As far as we compare sensations under the relation of intensity, we treat them as magnitudes: and if, from the point of view of the internal sense, we are led to say that a sensation is equal, inferior, or superior to another, it does not follow that we meet here an obstacle to all exact measurement. The time element at first consists in vague notions only of before, after, together; and this does not interfere with very exact measurement. And just as this exact measure must be found not in time itself, but entirely in movements in space, so the exact measure of sensation must be sought not in the sensation itself, but in external events which occur in space. Now what better measure for sensation can be found than the external movement from which the sensation arises? The excitation is not only the most direct, but indeed the only possible measure of sensation. Between the sensation and its measure, there exists a necessary relation. The sensation would not exist if the excitation did not precede it. Thus we take the cause as measure of the effect. The essential point of difference between the measurement of psychic and extended magnitudes, *is that in the former, the cause serves as measure of the effect; in the latter, the effect serves as measure of the cause.*

The property of sensations, whereby they increase and diminish, affords us a basis for their measurement. As we have seen, it is generally admitted that every sensation increases or diminishes as the excitation which causes it: when the sensation of light increases in the eye, we believe that there is more light without; and when sound in the ear is augmented, we believe that the noise without is also augmented. Further, common sense is disposed to assert that the sensation increases or decreases directly as the excitation. Herbart, who, as we have seen, attempted first to introduce measurement into psychology, finds it very natural to say "that two lights shine twice as brightly to us as one."[1] Yet this supposition is false. Certain facts of observation alone, without the aid of experiment, are sufficient to prove the law in accordance with which sensation and excitation vary, and to explain this law, at least in a general way.

Every one knows, says M. Delbœuf,[2] that in the silence of the night noises are heard that pass unperceived during the day: the tic-tac of the pendulum, the light wind currents that blow through the chimney, and other noises of this kind. In the din of the street, or in a train in motion, we do not hear our neighbor and sometimes not even our own voice. The stars, so brilliant during the night, do not appear by day, and the moon pales before the sun. To a weight of 10 grams in your hand, add another weight of 10 grams, and you will perceive the difference distinctly; but if you add 10 grams to a quintal, the difference is not perceived.

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[1] Herbart, *Werke*, vol. VII, p. 268.

[2] Delbœuf, *Recherches théoriques et expérimentales sur la mesure des sensations.* Brussels, 1873. Extract from the memoirs of the Acad. of Belgium.

These are every-day facts: it is generally believed that they are simple enough, and yet it is not so. For it is indisputable that the pendulum continues its tic-tac during the day; that we speak high on the railway train; that the moon and stars shine by day as by night, and that 10 grams always weigh 10 grams.

Other examples: "We know by experience to-day," says M. Delbœuf, again, "that in the great vocal and instrumental concerts in which the performers are counted by hundreds, the effect produced is not as great as we expect; that is, to double the number of singers is not to double the intensity of the sensation. We know also that in eclipses of the sun, a considerable portion of the disc may be darkened with no perceptible decline in the brightness of the day."

What do these phenomena signify? They signify that one and the same excitation may, according to the conditions in which it acts, produce a sensation more or less intense, or none at all.

And how is this change produced? The facts show that the conditions of the change are always the same, and that they may be formulated thus: *In order that an excitation be felt, it must be feebler as the excitation to which it is added is feeble, stronger as the excitation to which it is added is stronger.* We see that this is only a vague expression of the law formulated above by Weber: but it is still important to remark that ordinary facts show us before all experimental investigation, that the relation between excitation and sensation is not as simple as we supposed. For if the relation were the simplest possible, the sensation would increase directly as the excitation: to an excitation 1 would correspond a sensation 1; to an excitation 2, a sensation 2, and so on. But it is not so; otherwise an excitation would be always equally felt, whether it be added to a strong excitation or a feeble one: the light of the stars, for example, would be perceived equally by day and by night. The conclusion then from all this is: *that the intensity of the sensation grows, not proportionally to the intensity of the excitation that occasions it, but more slowly.*

Consequently this question arises: by how much is the increase in the sensation less than the increase in the excitation? Every-day experience can not reply to this: here the exact measurement of intensities is necessary.

It is impossible to measure directly the force of a sensation; we can measure *differences* of sensation only. To do this three methods of experiment have been hitherto employed, which Fechner, who brought them into use, designated by the names *Method of smallest perceptible differences; Method of true and false cases; Method of mean errors.*[1]

The first method (*der eben merklichen Unterschiede*) is this. We are to compare two weights A and B. If the difference of these two weights is very small, perhaps it is not possible to perceive it, and we judge them equal. On the contrary, if the difference is considerable, it will not escape our notice. If, then, the difference *d* of the weights A and B be made to grow, an instant will arrive when it passes from the imperceptible to the perceptible. In general, when we employ this method, we proceed in two opposite ways; first we cause the difference *d* to grow until it become perceptible; then we cause it to decrease until it cease to be. Naturally, the sensibility of the subject in judging differences is by so much *greater* as the quantity *d* is smaller.

The second method (*der richtigen und falschen Fälle*) consists in using weights whose difference is very small. Error is possible in the comparative judgment passed upon them. The heavier weight is sometimes designated as heavier and sometimes as lighter. In a word, in comparing each pair of weights on which judgment is given, there will be a certain number respectively of true and false judgments. As the difference in the weights increases, the number of true judgments increases at the expense of the number of false judgments. Let us represent the total number of cases as 100, and the number of true cases, 70: we have the relation $\frac{70}{100}$, obtained from the comparison of the two weights A and B. Now, given a weight *a* we may seek to determine the weight *b* which, compared with *a*, will give the same relation $\frac{70}{100}$. It must be noted that the uncertain cases are to be divided proportionally between the true and false cases.

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[1] Fechner, *Elemente der Psychophysik*, vol. I, pp. 71–76. We follow in general the exposition of Delbœuf, as it is much clearer than Fechner's.

The third method (*der mittleren Fehler*) consists in taking first a mormal weight A, determined in the balance, then in seeking to determine, by the judgment which accompanies the sensation alone, another weight B to be equal to A. In general, the second weight differs from the first by a quantity *d* which is smaller as the sensibility is greater. We repeat this attempt a great number of times, add the positive errors and the negative errors, disregarding signs, divide the total by the number of cases, and thus obtain the mean error.

"These three methods," says Fechner, "supplement one another, and lead by different routes to the same result. The first serves to determine the smallest perceptible difference. The second gives differences which exceed the smallest perceptible difference (they fall sometimes in the true cases, sometimes in the false); the third gives differences which are below." In practice, the first method is the simplest, most direct, leads proportionally soonest to the end, and requires least calculation. But, as is justly remarked by M. Delbœuf, lack of precision is its great defect. "Where and when does a difference in external excitation cease to be perceptible? We see how vast a field remains open to doubt."

III.

We are now done with the preliminaries on method. It remains to see the work itself and to say what results it has reached in the sphere of pressure, muscular, temperature, light, and sound sensation.

Sensations of pressure.—Let a man place his hand well extended on a table; then place on the hand any weight whatever. To this weight add a very small one, and ask the subject of the experiment (whose attention should be directed from his hand throughout) whether he feel the difference. If he reply in the negative, try a heavier weight, and so on until the additional weight cause a perceptible difference. After having done this with the first weight, repeat it with a second and third, until the necessary magnitude of the additional weight is determined in a sufficient number of cases.

Investigations conducted in this way lead to a result of striking simplicity. We find that the additional weight bears *a constant relation* to the original, whatever be the magnitude of the latter. For example, let us suppose it is found that for one gram the additional weight is one-quarter gram; for one ounce, one-quarter ounce; for one pound, one-quarter pound. In other words, to ten grams we must add two and one-half grams; to one hundred, twenty-five; to one thousand, two hundred and fifty.

These numbers show the nature of the law according to which sensations of pressure or weight change with changes in the external cause. This law is expressed by a number, and this number expresses the relation of the additional weight to the original. Now the mean of a great number of experiments gives as the expression of this relation one-third; that is to say, *given any pressure on the skin, an increase or decrease of pressure will not be felt unless the weight added or withdrawn be in the relation one-third at least to the original weight.*[1]

Sensations of muscular effort.—Experiments analogous in nature and of great number have been made on the sensation of effort (to raise a weight). But here the conditions are not as simple. When we raise a weight we have not a sensation of pressure in the hand alone; but also a sensation in the muscles of the arm which raises the hand and weight. In this case the sensation is much more delicate than in the case of simple pressure. Consequently, in the effort made to raise the weight, we perceive much smaller differences. And, in fact, exact investigations show that in the case of muscular effort we feel an additional weight only $\frac{1}{17}$ of the original. The sensibility, then, is in this case about five times greater than in the preceding.

The number $\frac{1}{17}$, therefore, expresses the law according to which the sensation of muscular effort depends upon the excitation. This number applies to all weights, great or small, be they grams, pounds, or kilograms: that is, to one hundred grams we must add six; in short, to any weight $\frac{1}{17}$ of that weight must be added in order that the difference may be felt.[2]

Sensations of temperature.—The skin is an organ of double sense. By it we feel not only the pressure, but the temperature of bodies which come in contact with us. To determine whether sensations of heat and cold depend on the intensity of the external excitation, we take two vases of water of different temperatures and plunge into each a finger of the same hand; then, by repeated trials, we find the smallest difference of temperature in the two vases to which a difference in the sensation of temperature responds. Calling the normal temperature of the hand zero, we find that, setting out from this point, in order that the sensation of difference may be preserved, the relative difference in temperature must be constant. Any temperature must be raised one-third in order that the increase be perceived in sensation.

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[1] Fechner, *Elem. d. Psychol.*, vol. I, p. 182, etc. Experiments of Weber and Fechner.

[2] Wundt, *Vorles üb. Mensch. u. Thierseele*, lect. 7, vol. I, p. 92. Experiments of Weber.

The law for sensations of temperature, then, is expressed by one-third, the same number as for sensations of pressure.[1]

Sensations of light.—We determine a weight objectively by means of a balance: we determine light objectively by means of the photometer. In a dark chamber a white screen is lighted by two candles A and B. Before the screen a rule is placed which throws two shadows, one A′ from the light A, the other B′ from B. When B is removed, the shadow A′ becomes darker. It is then easy to calculate the distances of A and B at which the shadow begins to grow perceptibly deeper. According to the laws of optics, the luminous intensities being in inverse ratio to the squares of the distances of the lights from the screen, we can deduce directly the smallest perceptible difference in luminous intensity.

The same method is applied to the subject in hand—to measure the relation between the sensation of light and its intensity. The portions of the screen brightly and feebly lighted (the latter where the shadow falls) respectively produce two sensations of light which differ more in intensity as the shadow is darker. If we place at first before the rule, two lights of equal intensity at the same distance, for example, two similar candles, the two shadows will have the same intensity, that is, will differ equally from the bright

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[1] Fechner, vol. I, p. 201. Experiments of Weber, Fechner, Volkmann, etc.

ground on which they are projected. If now we move one of the candles backward, the shadow which it projects will become more and more feeble; it will differ less and less from the bright ground of the screen; finally, it will disappear. The distance from the fixed candle to the screen is then measured, as also the distance of the second candle, whose shadow has been reduced to the disappearing point; thus we obtain data sufficient to show the relation of the growth of the sensation to that of the light. We may remark in effect; if the fixed candle be alone of course all the light of the screen comes from it. But let us now place the other candle at a very great distance. It adds to the original brilliancy, but this increase is not perceptible. And how do we know the moment that it becomes so? By the appearance of a second shadow projected from the rule: its position is illuminated by the fixed candle, but not by the moving candle. Consequently at the point where a perceptible increase is produced, the shadow must appear. The shadow, then, is only a sign to us of the increase of light. We have now only to apply the optical law for the relation of intensity to distance. Suppose that the first candle is one meter from the screen, and the second ten meters when a shadow barely perceptible is produced; the luminous intensities are in the relation 100 to 1, and consequently the luminous intensity of the first light must be increased $\frac{1}{100}$ in order that the increase may be perceptible in sensation.

The experiment is conducted here just as with the weights. There, we added a lighter weight to a heavier; here, we add a feebler light to a stronger. It remains only to extend our observations to excitations of different intensities, as has been done for weight. In this experiment we see that the two lights employed are always distant from each other by a constant relation. If the second candle must be removed ten meters when the first is one meter distant, it will have to be six feet when the first is one foot, twenty meters when the first is two meters.—It follows that the luminous intensities which produce the smallest perceptible difference have always the same relation, *i. e.:* 100 : 1, 200: 2, etc. We have found, then, a law here and this law is also set forth by a number expressing the relation of the barely perceptible increase of light to the original light. This number is $\frac{1}{100}$; that is, every luminous excitation must be increased by a hundredth in order that the increase may be perceptible.[1]

We may verify this law by another experiment. Let a white disc be provided that may turn very rapidly, and on the surface of this disc let a small black segment be marked out. We then inquire how large this segment must be made in order that, the disc turning rapidly, the eye may perceive a gray circle. The relation of the area of the segment to that of the circle is immediately the appreciable difference, and the constancy of this relation $\frac{1}{100}$, for variable luminous intensities, confirms the law.[2]

Sensations of sound.—In the domain of auditory sensation, similar investigations have been made and the following principle established: the intensity of the sound produced by a body in striking another, is proportional to the weight of the body that falls and the height from which it falls. If, then, we take a given body and vary the height of its fall, we may vary the sound also at pleasure. This principle can be applied as follows to the measurement of small differences in the intensity of sounds. Let us take two balls of the same size, *a* and *b*, made of the same material and suspended by threads of the same length. Pla between these two balls a small screen. Draw back o of the balls, *a*, to a given distance (a graduated circle fix to the screen serves to determine this distance exactly); i falling it produces a sound on the screen. Do the same wit the ball *b*. The sounds being proportional to the height o the fall, if the two balls are drawn back equal distances, equ sounds will result; if unequal distances, the sounds will b unequal. If, now setting out from the moment at whic the equality is perfect, we increase the differences in heigh gradually, when the two balls are allowed to fall in as quic succession as possible, in order better to compare them, i is ascertained that no difference in the sounds is remarke at first, although there is a difference in the heights. It i only when this difference has attained a certain degree tha it is perceived. At this instant, we measure the height o the two balls; and see how much the height must b increased to produce a perceptible difference. Supposin the height of the first ball is three inches and of the secon four, it results that the intensity of the sound must increas one-third in order that the difference be perceived. If w extend the trial to a great number of cases and very differ ent heights, we find in all, as in this case, that the relatio remains constant and consequently that the intensity o sound must be increased one-third to produce an increase i sensation.[1]

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[1] Fechner gives the fraction $\frac{1}{100}$; according to others, this constant value would vary between $\frac{1}{60}$ and $\frac{1}{166}$.

[2] Experiments of Bouguer, Masson, Arago, Steinheil, Volkmann, Fechner, etc. *Elemente d. Psychophysik*, vol. I, pp. 139–175. We will speak later of the important experiments of M. Delbœuf. See also Wundt, *Menschen u. Thierseele*, vol. I, p. 96.—Helmholtz, *Physiol. Optik*, p. 310, French trans., p. 411.

The experiments which we now sum up show that when- ever sensations of pressure, light, temperature, sound, an even of muscular exertion, increase continuously by th addition of the smallest differences perceptible in consciousness, there is in the corresponding excitation an increase which is *always the same* aliquot part of the entire excitation.

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[1] Experiments of Renz and Wolf, Fechner, Volkmann, Schaffhäusl etc. *Elem. d. Psychophysik*, vol. I, page 195, etc.—According to Renz an Wolf (*Vierordt's Archiv.*, 1856), in order to distinguish two sound clearly, their relation must be 100 : 72. The limit at which true pa into false judgments is 100 : 92. Volkmann's relation is 4 : 3, nearl equivalent to 100 : 75.

Sensations of taste and smell remain. The former were studied by Keppler in 1869, by the method of true and false cases; but his experiments do not confirm the theories of Fechner.[1] We can now sum up what precedes in the table below and say: In order that sensation may increase by the smallest perceptible difference, the excitation must increase:

For touch	$\frac{1}{3}$
For muscular effort	$\frac{1}{17}$
For temperature	$\frac{1}{3}$
For sound	$\frac{1}{3}$
For light	$\frac{1}{100}$

IV.

These figures led Fechner, as we shall see later, to the discovery of a very general law to express the relation of *all* excitation to *all* sensation.[2] But before arriving at this law, he makes a preliminary investigation; this is to discover the smallest perceptible sensation.

To construct a graduated scale upon which to measure the relation between excitation and sensation, it is not sufficient to have found an unit of division for the parts of the scale; we must also know from what point the graduation is to begin. Where shall we place the zero? Evidently, in dealing with sensation, the zero of the graduated scale

[1] On this point and on Fechner's critics, see *In Sachen d. Psychophysik*, p. 161, etc.

[2] Fechner distinguishes between intensive and extensive sensation. The latter might more exactly be called perception *of* the different manifestations *of* extension. It may be remarked that his law applies especially to the former.

must be put where the smallest perceptible sensation is produced, the smallest sensation in consciousness.[1] This point is designated by Fechner by a word borrowed from Herbart, the *threshold* of excitation (*Reizschwelle*), and he applies it "as well to the sensation as to the excitation at that point."[2]

It is necessary, therefore, to determine by a series of observations and experiments the exact value of the threshold for each kind of sensation. We will take them up in order, setting aside various details that would complicate the exposition to little profit.

Weight.—The investigation in sensations of weight is easily made. We place on the point of the skin whose sensibility we wish to test a small weight of cork or elder-pith, and by repeated trials, ascertain the magnitude of the weight which is barely felt, that is, which produces the perceptible *minimum*. A great number of experiments conducted in this way have proved that the sensibility of the skin varies greatly in the different regions explored. The most sensible regions are the forehead, temples, eyelids, and the back of the hand: at these points we feel $\frac{1}{500}$ of a gram. The palm of the hand, the belly, the legs, &c., are less sensitive regions, their perceptible *minimum* being as low as $\frac{1}{20}$ of a gram. Finally, on the nails and heels, it is lowered to 1 gram. To sum up, the limit of the excitation, as established by a great number of experiments, is given according to Aubert, by a pressure of 0.002 to 0.05 gr.[3]

For the muscular sense, the perceptible minimum is represented, according to Wundt, by a contraction of 0.004 mm. of the right inner muscle of the eye.[1]

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[1] The question is more complicated than we have for the present indicated; as the sensation is measured by means of the excitation, an agreement must be established between the two graduated scales; difficulties arise which will be examined later, in the critical part of the work.

[2] See *Elemente d. Psychophysik*, vol. I, p. 238 and fol.

[3] Experiments of Weber, Kammler, Aubert, &c. *Elemente d. Psychophysik*, vol. I, p. 163, &c., in particular, p. 264.

Sound.—To determine the limit of excitation for the auditory apparatus, we must take account of several things; the weight and material of the body which produces the sound, the material of the body against which it strikes, the velocity of sound, and the distance between the ear and the *locus* of the sound.

To measure the perceptible *minimum* of sound, two methods may be pursued: we may remain throughout at a fixed distance from the sonorous body and cause the intensity of the sound to diminish by degrees to the limit of perception; or we may withdraw gradually from a sonorous body, of any intensity, until the sound is no longer heard. Since the sound diminishes as the square of the distance, we find by measurement at any point exactly how much the sound has diminished.

If a small ball of cork be allowed to fall on a plate of glass, the intensity of the sound so produced will vary according to the weight of the ball and the height from which it falls. Now we find that the sound produced by a ball of cork one milligram in weight, falling one millimeter, the ear being distant ninety-one millimeters, produces *the smallest perceptible sound.*

This determination made, it is necessary to make the sound thus produced an *unit*, to which all other sonorous intensities may be referred. To accomplish this, we proceed as follows. We take any sound whatever, whose intensity is to be measured, and withdraw from it until it is barely perceptible. This is exactly the perceptible minimum, as we have determined it above; and by measuring the distance we find how many times this sound, at the point at which it is produced, is more intense than the sound of the ball of cork. Take, for example, the noise of a musket charged so as to be heard at seven thousand meters. This distance is about seven hundred thousand times greater than ninety-one millimeters. It results, then, that the intensity of the sound of the musket will be about four thousand nine hundred million times as great as the chosen unit.

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[1] Wundt, *Physiologie d. Menschen*, French Trans., p. 420.

We may proceed, similarly, with all other sonorous intensities. But these measurements must be made in the silence of the night, when the ear is not disturbed by other sounds, and when the atmosphere is more uniform in consequence of the absence of solar heat.[1]

Light.—Great difficulties arise in determining the perceptible *minimum* in the range of sensations of light. It seems, at first, that the *external* conditions of the phenomena are precisely the same as in the other cases; but it is soon evident that the *internal* conditions are so different that the investigation becomes singularly complex.

The determination of the perceptible *minimum* can naturally be arrived at only when the organ of sense is in a state of repose, i. e. perceiving nothing. Such is the case with the ear: silence is distinguished from noise by the absolute lack of sensation. It seems that in the case of the eye, darkness is to be distinguished similarly from light. But it is not so: darkness differs from light only in degree. If we shut our eyes, darkness results abruptly, but never the entire absence of sensation. External light always penetrates a little. Besides, the natural pressure of the sphere of the eye excites the retina; so much so that, when the pressure is increased, this internal light increases also.

But admitting that this mechanical excitation does not exist, and that as far as it is concerned we are in the darkest night, there is none the less light in the eye. It is what is called *its peculiar light*. "The field of vision of the normal man," says Helmholtz,[1] "is never completely free from those apparitions which have been called luminous chaos, the luminous dust of the obscure field of vision." This phenomenon was first studied by Gœthe, J. Müller, and Purkinje. The last mentioned relates that after some physical exertion "he saw a light of feeble intensity, comparable with the last glimmerings of burning alcohol, waving and flaming in his darkened visual field." This luminous chaos is certainly independent of *external* light, since it is present when the latter is completely wanting, follows us in our movements and does not respond to any external object. Finally, the most profound darkness itself is a sensation of light. "The obscurest black is not the absolute lack of sensation, but the feeblest sensation of light. The dark has degrees of darkness; there are differences in black: the deepest black becomes in succession, clearer black, then gray, then white."

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[1] Experiments of Schaffhäutl, Delezenne, &c. *Elemente d. Psychophysik*, p. 257, &c.

This internal excitation of the eye, having its cause, perhaps, in the chemical processes of nutrition that take place in the tissues, perhaps, rather, in the motor muscles of the eye, which are always more or less in a state of contraction, presents, as it appears, a very serious difficulty to the measurement of the perceptible *minimum*. The eye is in a state of continual permanent sensation, and all the excitation we produce only adds to this unending sensation. We are incapable of determining here the excitation that corresponds to the zero of sensation. Yet, if we decide that the sensation experienced by the eye in the deepest darkness shall be zero, then this sensation will be the perceptible *minimum*, and the excitation which causes it, the unit of excitation. This manner of procedure will conduct us to something definite. In truth, we commit error; but the error is so small that it may be neglected, especially as, in the majority of cases, we deal with luminous intensities which are very great, and as, consequently, the final result is not involved in the investigation of the *unit*. We can not proceed here as in the preceding cases, for there we had to determine the excitation which produced the smallest sensation possible. Here a sensation a little above the *minimum*, but accepted for it, is given. It is the corresponding excitation that is unknown; and we must measure it.

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[1] *Physiologische Optik*, p. 202, French trans., p. 274.

The method to be followed in determining the luminous intensity of a darkened eye is that which we have already employed to measure the intensity of any external light. It will be recalled that the process consisted in the projection of two shadows on a screen, by means of two lights placed in front of a vertical rule. In the case before us, the eye itself is the luminous source, whose intensity we wish to measure. In the experiment, conceived by Volkmann, and of which we will give an outline, the light peculiar to the eye is compared with a light whose intensity is known. We place the vertical rule in a dark recess, and, at some distance, both the light which serves as measure and the light to be measured, *i.e.*, the eye. Let us conceive the shadow projected by the rule upon the screen; and at the same time let the light be removed further and further. In consequence, the shadow grows dimmer and dimmer, and finally ceases to be visible. At this instant, the part of the screen which is lighted only by the peculiar light of the eye is no longer distinguished from the other portion—from that which receives the external light, plus the light of the eye. Here is, then, the exact point at which the external light is so feeble that it gives no longer a perceptible increase upon the light of the eye. Since we know from earlier investigation that the proportional constant i $\frac{1}{100}$ for light, and since we can determine the distances, w have sufficient data to calculate the peculiar light of th eye.[1] Volkmann used for his experiments a screen of black velvet and an ordinary candle, and found that this candle at a distance of about nine feet (eight feet, seven) produced a light equal to the peculiar light of the eye. It remains to make of the quantity of light thus determined a *unit* to be used in practice. To do this, this unit must be compared with the other different luminous intensities employed as excitants. This task presents no difficulty since the subjective light has already been successfully referred to a luminous intensity which is objective, and, consequently, measurable.

Temperature.—Here difficulties present themselves of another nature entirely than those of vision. The skin, we cannot doubt, experiences sensations of heat constantly. We must then determine how much this temperature of the skin, at the point where neither heat nor cold is felt, is to be raised or lowered, to produce the perceptible *minimum* of heat or cold. Now, two difficulties arise that have not as yet been completely overcome: 1st, The nerves of the skin at that temperature at which there is no sensation of heat are so sensitive that we feel any elevation or depression of temperature even before the thermometric instruments can register it with precision. 2d. The temperature at which no sensation is felt, and which answers, consequently, to the excitation *zero*, is not the same for different parts of the body, and varies, probably, for the same part. This is easily seen by putting different parts in contact. Beforehand, no sensation of temperature is felt; but, upon contact, one part is felt to be warm and the other cold. Thus, if the hand is placed on the forehead or cheeks, it seems clearly cold and the cheeks or forehead warm. The portion of the skin which covers the trunk is warmer than that of the extremities. The fingers are warmer than the rest of the hand, and, of the hand, the back is warmer than the palm.

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[1] Let us call, says Fechner, the intensity of the peculiar light H_0. When an eye capable of perceiving a difference of $\frac{1}{100}$ regards a surface, a part of which receives no external light, and a part of which has the intensity h, we have H_0 and H_0+h as the apparent intensities of the two parts, in dealing with the peculiar light of the eye. If h be the feeblest intensity perceivable, we have $h=\frac{1}{100}H_0$; thus the intensity H_0 of the peculiar light is measured by the objective light.

As far as the hand is concerned, it is admitted that 19° centigrade represents the state of no perceptible excitation, and that an elevation or depression of $\frac{1}{8}$° centigrade produces the perceptible *minimum* of heat and cold. Until the degree of temperature which answers to the excitation zero is determined for all parts of the body, the general law can be applied to sensations of temperature only in an incomplete way. Yet we may consider the human skin as having the mean temperature of 18.4° centigrade: if we place the zero of excitation at this point, the error will not be great. At present, the perceptible *minimum*, in the case of elevation or depression of temperature, has not been fixed exactly. However, it is set generally at $\frac{1}{8}$° centigrade.

We gather up, in the following table, the results of the experiment:[1]

For touch	Pressure of 0.002 to 0.05 gr.
Muscular effort . .	Contraction of 0.004 mm. of the right internal muscle of the eye.
Temperature . . .	(The heat of the skin being 18. 4°) $\frac{1}{8}$° centigrade.
Sound	Ball of cork of 1.001 gr. falling 0.001 m. on a plate of glass, the ear being distant 91 mm.
Light	Cast on black velvet by a candle situated 8 ft. 7 in. distant.

For the perceptible *minimum* in the sphere of vision,

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[1] *Elements d. Psychophysik*, vol. I, p. 267.

Aubert gives as unit the intensity of a light about three hundred times feebler than the full moon.

V.

THE PSYCHO-PHYSICAL LAW.

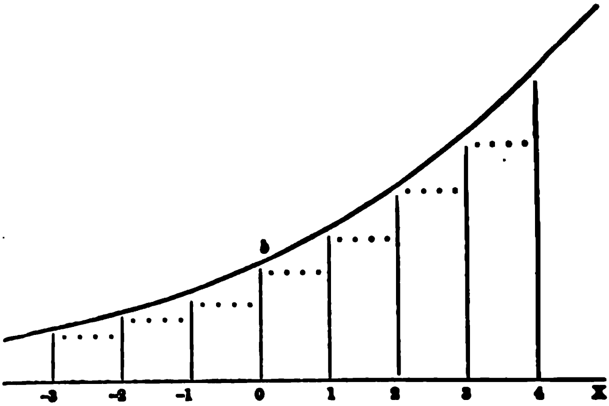
These facts will now serve to give a connected view of our subject, that is, to allow the deduction of a law to express the general relation of excitation to sensation. By how much must a given excitation be increased to produce a determined increase in the corresponding sensation? If I increase an excitation by a determined quantity, in what proportion does the corresponding sensation increase? We are in a state to reply to these and other questions of the same kind.

Excitation and sensation are magnitudes dependent upon each other. Both are expressed in numbers. The expression for the sensation increases when the expression for the excitation increases. But in what relation? The simplest relation would evidently be this: that successive excitations be represented by the numbers 1, 2, 3, 4, etc., and the sensations by the corresponding numbers 1, 2, 3, 4, etc. We would say, in this case, that the sensation grows proportionally to the excitation; that when the excitation is doubled, tripled, quadrupled, the sensation is likewise doubled, tripled, quadrupled.

But this is not the case. It is not so simple; the excitation grows much faster than the sensation.

But there are many ways in which a series of quantities may grow faster than a corresponding series. For example, the excitation might grow as the square, the cube, etc., of the sensation. But this still is not the case; the numerical ratio which expresses the relation of sensation to excitation is more complex.

We may indicate it in a simple manner as follows:



Let us draw a straight line X of a given length; and at some point of this line place a zero. This point indicates the perceptible *minimum*, for example, $\frac{1}{10}$ gram if we are dealing with sensations of pressure. Setting out from the point 0, we divide the line X into equal parts indicated by the figures 1, 2, 3, 4, etc., on the right. From the point 0, we draw a vertical line 0*b* of any length to represent the perceptible *minimum*. Now since the proportional constant, that is, the smallest perceptible difference, is one-third in the case of pressure, we must draw from the point 1 a line $= 0b + \frac{ob}{3}$; from the point 2, a line equal to the line at 1 plus one-third of that line; from the point 3, a line equal to the line at 2 plus one-third of that line, and so on. We understand that the increase must always be by one-third, and, as these vertical lines have always the same relation to each other as the weights they represent, it is clear that the differences of length between the line 0 and the lines 4, 5, 6, etc., indicate the weights which must be employed to quadruple, quintuple, sextuple, etc., the perceptible difference.

If we join the extremities of the vertical lines which represent the magnitudes of the different excitations, there results a curve which exhibits to the eye the way in which the sensations depend upon the excitations, not only for the points 1, 2, 3, 4, &c., but for all the points lying between them, for example, 1¼, 1½, etc., etc. For it is evident that the equal lengths 1, 2, 3, etc., can be divided into parts as small as we please, and, if it is desired to find the intensity of the excitation that corresponds to any point situated between two units, we have only to join this point, by a vertical line to the curve: the length of this line will give the magnitude of the excitation sought. The difference of sensation that answers to the point between two units is perhaps not perceptible to us; but we cannot conclude that it does not exist. The perceptible difference can be obtained only by accumulating a great number of imperceptible differences.

Our measure, then, is continuous, and the curve that represents the increase in sensation, proportional to the increase in the excitation, passes from the imperceptible to the perceptible, precisely as the sensation itself. This curve is, in its nature, infinite in two directions and never cuts the line X.[1]

This prepares us to understand better the law formulated by Fechner. He tells us (*Elemente d. Psychophysik*, vol. II, pp. 553 and 554) that after much reflection and many fruitless efforts, he discovered finally, "one morning the 22d. October, 1850, while lying in his bed," a method that seemed sufficient to measure sensation by means of excitation.

To be better understood, we will first indicate in a general way, and without mathematical details, the course pursued by Fechner.

We have two series before us: that of excitations and that of sensations. The problem is to measure the second by means of the first. The quantitative value of the excitatio and its increase can be determined. In dealing with weight light, or sound, we are able, by experimental processes mor or less complex, to affirm that the initial excitation is increased a third, a fourth, is doubled or tripled, etc. But i is not so with the sensation. Consciousness cannot inform u whether the initial sensation has increased a third, a fourth has doubled or tripled. We must then have recourse to a indirect method, and this method consists in determinin the smallest perceptible differences of sensation; then i determining the relation existing between the differences o excitation which grow *progressively* and the differences o sensation which grow *uniformly*, and in expressing, thu the sensation in terms of the excitation.

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[1] Wundt, *Menschen u. Thierseele*, vol. I, lect. 8.

We will now enter into some details. The method o Fechner is based from the beginning upon the followin mathematical principle:

The increments of two continuous magnitudes which ar functions of each other continue proportional as long as the are very small. "But," says Fechner (vol. II, p. 7), "thi term 'very small' is entirely relative. Speaking absolutely the proportion will hold only for infinitely small increments the approximation will be greater as they approach neare the infinitely small. With this reservation, we may sa 'that the increments of sensation are proportional to th increments of excitation, while the increments of each ar very small.'"

Assuming two principles, *i. e.* 1st. That differences of sensation are equal among themselves, when the corresponding differences of excitation are relatively equal among themselves (principle of Weber); 2d. That small increments of sensation are proportional to the increments of excitatio (mathematical principle stated above), Fechner reason thus:

"Let the increment of the excitation be, agreeably to the investigations of Weber, very small in proportion to the excitation itself. Let us call the excitation β and the increment $d\beta$ (the letter d signifying no particular magnitude, but only the smallest increment of β which can be considered its differential). The relative increment of excitation is then $\frac{d\beta}{\beta}$. On the other hand, let us call y the sensation which depends upon the excitation β, and dy the increment of sensation produced during the growth of the increment $d\beta$ (d having the same meaning as above). . . .

"According to the experimental investigations of Weber, dy remains constant, while $\frac{d\beta}{\beta}$ remains constant, whatever absolute value β and $d\beta$ may have. And, according to the *a priori* mathematical principle already given, the increments dy and $d\beta$ are proportional to each other, while they are very small. These two relations are expressed in the following equation:

$$dy = \frac{k d\beta}{\beta},$$

k being a constant."

Whence, by integration: $y = k \log \beta$.

Which gives the value of the sensation.[1]

This is the result of the investigation, and Fechner has stated it concisely in the famous formula called the psychophysical law:

The sensation grows as the logarithm of the excitation.

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[1] Fechner, *Elem. d. Psychophys.*, vol. II, pp. 9 and 10.—The following is an exposition of Fechner under another form in greater detail, which I owe to the kindness of M. Delbœuf.

"Fechner proceeds by the method of perceptible *minima* of sensation, and assumes that:

"1st. All these *minima* are equal, *i. e.*, the sensation of an increase of weight, light, etc., is always the same, whatever be the weight or light to which the increase is added.

"2d. Experiment shows that this sensation of increase is produced whenever the increase in excitation is an aliquot part, always the same, of the total excitation.

This law has been put in other forms, simpler and less transcendent in a mathematical sense (by Weber, Delbœuf, Budge, &c.), for example: *In order that the sensation grow by quantities always equal, it is necessary that the external excitation grow by quantities always proportional to the excitation itself,*—or again: the excitation must grow in geometrical progression (such as 1, 2, 4, 8,—or 1, 3, 9, &c.) in order that the sensation may grow in arithmetical progression (such as 1, 2, 3, 4, &c.). In fact, the logarithms of numbers which form a geometrical progression are in arithmetical progression.[1]

"3d. If we express this under the form of a differential equation, the only exact form for this sort of phenomena, we have:

$\Delta\varsigma$ (increment of sensation) =k (indicating proportion, not equality) $\times \frac{\Delta\epsilon}{\epsilon}$ (the relation of the increment of excitation to the total excitation), *i. e.*:

$$\Delta\varsigma = k\,\frac{\Delta\epsilon}{\epsilon}.$$

"Fechner, by a process which is legitimate in certain circumstances, transforms this equation of finite differences into an equation of infinitely small differences (criticism of this process could only result in showing that the resulting equation is only approximate). It is then written:

$$d\varsigma = k\frac{d\epsilon}{\epsilon}.$$

"In this way we obtain an equation which may be integrated, that is, one which gives a relation not between $d\varsigma$ and $d\epsilon$, which are now infinitely small, inestimable, but between ς and ϵ, the end desired. This relation is

$$\varsigma = k \text{ loq. } \epsilon,$$

in consequence of some transformations indicated in my *Etude psycho-physique*, and in Fechner himself, *In Sachen d. Psychophys.*, p. 10."

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[1] On this point, see Wundt *Menschen u. Thierseele*, lect. 8, p. 116. We borrow some examples from him. In our tables, 10 being the base, this is the most convenient way to proceed. Put the sensation 1 under the excitation which is equal to ten times the perceptible minimum. This done and any excitation expressed by a number being given, we have only to look for this number in the table: the logarithm at the side gives us at once the value of the corresponding sensation. We know

VI.

FECHNER'S CRITICS.

We have now exhibited the great characteristics of the psycho-physical law and the experiments upon which it is based. As far as possible we have followed Fechner himself, borrowing from others only some details which were necessary to make his thought clear and complete. It remains to speak now of the critics, whose existence we have seemed hitherto to ignore. Yet, if the importance of a theory may be measured by the number of attacks made upon it, psychophysics must be considered of great value. Objections come from all sides, under all forms, and it is by no means a slight difficulty to present them in order.

It is well to remark from the very first that the law is true only *within certain limits.*

Just as there is a lower limit below which the excitation is too feeble to produce the nervous movement which is the condition of sensation; so there is also an upper limit above which sensation increases more slowly than the logarithm of the excitation, and a point is finally attained above which any increase in the excitation does not increase the sensation. As touching luminous intensities, common experience teaches that if the light diminish much, we can no longer

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that for pressure the perceptible minimum is $\frac{1}{50}$ gr. Let us then call the excitation of $\frac{1}{50}$ gr. = 1; an excitation ten times as great will be $\frac{1}{5}$ gr. Under this excitation let us place the sensation 1. Suppose now that I wish to make the sensation two and one-half times stronger. I take the table and opposite the logarithm 2.5, I find the number 316, that is 316 units of excitation, or $\frac{316}{50}$ gr., or, more simply, 6.3 gr. Let us now reverse the operation. Let there be an excitation of 5000 units (or 100 gr.); the question is to find the magnitude of the sensation it produces. I find in the table the logarithm of 5000 to be 3.699, that is, that a pressure of 100 gr. produces a sensation 3.699 times greater than the sensation produced by $\frac{1}{50}$ gr. Wundt has given a complete exposition of the law of Weber in the 2d edition of his *Physiol. Psychol.* I, sec. 2, chap. 8.

distinguish anything; and if the light be very bright there results a general daze. But scientific experiment warrants more positive statements. Fechner had already pointed out the anomalies which the psycho-physical law presents in cases in which the luminous sensations are very strong or very feeble. Aubert and Helmholtz show, further, that these anomalies are even slightly greater than was at first believed. Aubert's researches demonstrate that, when the luminous intensity is very feeble, the *differential constant* may fall as low as $\frac{1}{17}$.

Upon these partial restrictions, which bear only on the limits of the law and on but one order of sensations, more general criticisms follow.

Bernstein,[1] while admitting Fechner's law and the logarithmic form of it, gives it an altogether different meaning. The fact he insists more particularly upon is the propagation of the excitation in the central organs, that is, in the cerebral cells. According to him, the intensity of the sensation is *proportional* to this "propagation in space," i. e. to the number of vibrating cells; but this "propagation" represents in intensity the logarithm of the external excitation. The law would have thus a purely physiological character.

Brentano, in a passage in his *Psychologie aus empirischen Standpunkte*, 1874 (p. 87, &c.), and in a correspondence with Fechner, which the latter has told us exists,[2] criticising the psycho-physical law, maintains that the relative increments of sensation must be equal when the relative increments of the excitation are. Fechner placed this criticism with those which Plateau and Ueberhorst addressed to him.

In 1876, Sanger, in his book on the *Foundation of Psy-*

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[1] *Zur Theorie des Fechnerschen Gesetzes der Empfindung*, in the *Archiv* of Reichert and Dubois-Reymond, 1868.

[2] *In Sachen d. Psychophysik*, p. 24.

chophysics,[1] emphasized especially the mathematical side of the law of Fechner and proposed another formula to express the relation between sensation and excitation.

But the most complete criticism which has been made of the work of Fechner in all its details is due to Hering and Delbœuf.

M. Hering, professor in the University of Prague, as the preceding chapter has already informed us, in a series of articles or memoirs published 1872 to 1875,[2] attacked psychophysics at every point, or nearly so, denying or contesting nearly all the positions of Fechner. He rejects the latter's experiments or admits them only with extensive limitations; he denies that the logarithmic law is a legitimate deduction from the law of Weber; he deprives the law of all generality, and maintains that it is verified so far only for light and sound, and that in a certain measure. To the physical and mathematical objections, he adds others which he denominates teleological: in short, it is the severest assault that the doctrine of Fechner has had to meet.

The position of M. Delbœuf is more complex. More a partisan than an adversary of psychophysics, known himself from important experiments and works on this subject, he still does not admit the mathematical formulas of Fechner; and as to the doctrine as a whole, he rejects part and modifies what he does not reject. In his eyes, the *Elemente d. Psychophysik* is a work worthy of admiration, but, in coming time, it will be valued rather for what it suggests than for what it accomplishes. He has given his views in his *Étude psychophysique*,[3] in his *Theorie generale de la sen-*

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[1] *Grundlage der Psychophysik: eine kritische Untersuchung*, Jena, 1876.

[2] Six memoirs relating to visual sensation, but especially the articles *Ueber Fechner's psychophysisches Gesetz. Wien. Bericht*, vol. 72, 1875.

[3] *Étude psychophysique.* Theoretical and experimental investigations on the measurement of sensations, and especially sensations of light and fatigue. *Acad. des sciences de Bruxelles*, 1873.

sibilite, and in three important articles in the *Revue philosophique.*[1] In these last he defends Fechner against Hering and discusses the new book in which Fechner replies to his critics.

We see that in its short life of twenty years psychophysics has not been left undisturbed. And there are other critics to be mentioned: Mack, Classen, and an anonymous mathematician in the *Revue philosophique* of March 13 and April 24, 1875.

Fechner believed that all the objections brought against him could be stated under the following five heads:[2]

1st. The laws and formulas of psychophysics do not accord with the facts: they are mistakenly deduced: experimental research shows more exceptions to these laws than confirmations of them.

2d. Admitting that these laws and formulas are valid for external psychophysics, they cannot be carried into internal psychophysics. In other words, they have only a physiological value.

3d. They are open to mathematical objections and are unsound.

4th. They are irreconcilable teleologically with a rational conception of the external world.

5th. The psycho-physical formulas, consequently, must be abandoned or modified: or if they are formally established, must be interpreted in an entirely different way.

We will not enter equally upon all these points. We will examine especially the objections relating to the value of the experiments, to the mathematical interpretations, and finally to the nature of the law itself.

I. Hering, as we have said, contests nearly all the experiments of Fechner. As to sensations of weight, he devoted himself with two of his pupils to repeated experiments during many months. He starts with 250 grams, and by successive additions reaches 2700 gr. According to the law of Weber, the additional weight giving the smallest perceptible difference in sensation must be a fraction always constant of the original weight; now experiment shows that this fraction becomes smaller and smaller to a certain point, and then begins to grow again. The following figures prove it: [illegible]. In truth, Hering knows that if the weight of the arm be taken into account these figures will be modified[1] favorably to the psychophysical law. But, operating with weights much smaller (from 10 to 500 grams) and modifying the experiment in such a way as to rule out the weight of the arm, he finds that the fractions still fail to confirm the law of Fechner.[2]

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[1] March, 1877, Jan. and Feb., 1878.

[2] *In Sachen der Psychophysik*, pp. 13, 14.

For luminous sensations, Hering seems disposed to admit the law. M. Delbœuf does the same; but insists upon the limitations of Aubert and Helmholtz, relying upon his own experiments. "Let us imagine," says he, "three concentric contiguous rings colored in such a way, for a given illumination, say that of a candle 25 centimeters distant, that the middle intermediate shade shall appear in brightness equally removed from the brighter on one side and the darker on the other. If the candle be removed, this shade ceases to be intermediate between the two others, but approaches the darker. The law is not applicable at the extreme limits." On the other hand, he asks how Hering's principle of proportion can accord with this fact: that a gray, mean between a white whose brightness is 32, and a black whose brightness is 2, has a brightness not of 17, but of 8, the exact number required by the law of Fechner.

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[1] [illegible]

[2] Fechner, in his turn criticising the experiments of Hering, shows that if the weight of the arm is allowed for, i. e., 2,278 gr., the fractions are: [illegible]. (*In Sachen u. s. w.*, p. 192.)

As to sensations of sound, Hering distinguishes intensity and pitch (*tonalité*), and maintains that the psycho-physical law holds for neither. If the intensities of sounds, says he, follow a logarithmic law; if, as they increase, the corresponding sensations increase more and more slowly, the *timbre* of an instrument would vary to us according to its remoteness or nearness to us, in *forte* and *piano*; the *timbre* in effect, as Helmholtz has shown, is due to the combination with the fundamental note, of consonant notes, vibrating with definite relative intensities. In reference to pitch, Hering gives an objection not at all conclusive. He acknowledges, as has been known from all antiquity, that two musical intervals seem equal when the relation of the numbers of vibrations of the two constituent tones remains the same for the two intervals; but the tones not being perceived as a determined *number* of vibrations, it matters little, according to him, that the numerical relation of the intervals remains the same. Delbœuf has replied to these criticisms,[1] and shown, notably for sound, that the sensation is a subjective phenomenon, having a nature peculiar to itself, and that it perceives numerical relations in its own way, without perceiving them as numbers.

Besides smell, which no experiment has touched, and taste, which, as we have seen, defies the law, temperature remains. Now Fechner, in his latest work, acknowledges that for sensations of this kind, the question is still open.[2]

To sum up, the merciless critic, Hering, comes to this conclusion: that the psycho-physical law cannot be applied to smell, taste, heat, weight or sound, that it is only in a measure verified for sensations of light; that, consequently, it has not the general character of a law of the sensibility. M. Delbœuf, on the contrary, though criticising many details, believes that we can give it a provisional acceptance as far as the experimental question is concerned.

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[1] For the details of this reply, see the *Revue philosophique*, vol. III, p. 236 and fol., March, 1877.

[2] *Ich halte die Frage der Beziehung des Gesetzes zu diesen Empfindungen noch nicht für erledigt* (p. 165).

II. The mathematical validity of the law has given rise to difficulties of another nature.

The gravest is this: Do we admit, with Fechner, that, when a sensation grows by the smallest perceptible differences these differences ds, ds', ds'', remain always equal? On this hypothesis, as we have seen, all his mathematical deductions rest.

Wundt, who defends the position of Fechner on this point, maintains that "we are conscious, in certain given cases, that one sensation has decreased or increased as much as another, notably in the case where the increase (or decrease) is of a perceptible *minimum* of magnitude. These changes of a perceptible *minimum* in sensation are necessarily equal to each other in magnitude. If the change of either of the two sensations compared were greater or less than the other, it would be therein less than the perceptible minimum, which is contrary to the hypothesis. The sensation then has entirely the character of a measurable magnitude—measurable always in certain conditions, *i. e.*, in conditions of very small changes of value."

M. Delbœuf, who has many times declared the law incapable of being sustained from a mathematical point of view, accepts neither the hypothesis of Fechner nor the justification of Wundt, and subscribes to the criticism of the anonymous mathematician, who was spoken of above. The latter says that if the psycho-physical law be true, it is necessary that sensations be represented by numbers; that it would be well to say of what measure they are the expression, by means of what unit they are arrived at; that this is the method of procedure in physics, where the units are defined with great care, and the process of measure described: here nothing of the kind appears. In fact, Fechner measures sensation by excitation. All that precedes has shown abundantly that his process of measure rests on the relation of dependence existing between the excitation and the sensation that results from it, and that thus, according to his expression, "the internal sensation is measured by an external measure." Now here, says M. Delbœuf, is a pure illusion. Sensation must be measured by its natural unit, which can only be sensation. The excitation in its turn must be measured by a unit of excitation. In this way sensation and excitation are reduced to numbers which can be compared for reduction to a common law. It is only after the law has been discovered that we can take the measure of the sensation, and deduce by calculation that of the excitation.[1]

In addition to this general criticism, there is another on the method pursued by Fechner to establish his scale of comparison between sensation and excitation. In the construction of this scale of measure, it is important to fix the position of the zero as the point from which the graduation proceeds. For sensation, it seems natural to place the zero at the vanishing point; so Fechner proceeds. But, objects M. Delbœuf, it results in a grave difficulty. The external excitation, to be felt, to become a state of consciousness, must have acquired a certain intensity, must have passed its zero point. At the precise moment when the excitation attains its "threshold," that is, a degree of intensity just sufficient to be felt, Fechner takes this "threshold" as the *unit* of excitation. At this threshold, he places the zero of sensation. To the excitations that are below the threshold, that, consequently, are not felt, correspond *negative* sensations.[1] It follows that opposite the excitation 0, the sensation negative indefinite is written; opposite the sensation 0, the excitation 1 is written. It is not so that we proceed in experiments involving exact measurement. If, for example, says M. Delbœuf, we wish to measure the space passed over by a falling ball by the time elapsed since the beginning of the fall, and thus compare portions of space with portions of time, we take care that there be a perfect agreement between the starting points of the two series, that the time 0 be opposite the space 0.[2]

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[1] In his *Étude psychophysique*, M. Delbœuf attempts to determine for sensations of light a unit of sensation to be used as measure, and has given mathematical formulas to be substituted for those of Fechner.

III. The teleological criticism of the doctrine of Fechner would not detain us here, if it were concerned simply with metaphysical hypotheses, or a question of final causes; but it enters into the life of our subject, since its object is to determine the true character of the psycho-physical law. According to Hering, the most natural hypothesis, that which arises at once in thought, is that the effect is proportional to the cause, and that consequently, in the present case, the sensation must be proportional to the excitation. This hypothesis is so simple, clear, and satisfactory, that very good reasons must be given for rejecting it.

This reasoning seems correct, and, in its abstract form, only expresses a very general law of the phenomenal world, i. e., the transformation of forces. The principle of the direct proportion of cause and effect is but the metaphysical translation of this generalization, which is based upon numberless and uniform experiences: nothing is created, nothing is annihilated, all is transformed. But in the case we are dealing with, there is nothing to prove that the sensation is the entire effect produced by the excitation. Even to those who do not admit the law of Fechner in its rigorous form, it is beyond doubt that the sensation does not grow directly as the excitation. Many facts prove it. There must be, then, some causes of waste. The excitation does not produce a psychic effect alone—sensation; it produces other effects of a physical and physiological order that must occasion a certain expenditure of its original intensity. It acts upon an elastic and compressible medium in such a way that the psychic phenomenon is connected with a phenomenon of compression or expansion. So there is nothing here to contradict the proportion of cause to effect.

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[1] This expression has been greatly criticised, especially by Delbœuf and Langer. It would seem that negative sensations are unconscious; Fechner says that this interpretation is nonsense. M. Delbœuf also considers the notion of threshold unimportant; but we cannot embrace all the details of the question here.

[2] For a general criticism of mathematical psychophysics, see an article by M. P. Tannery, in the *Revue philosophique* for Jan. 1st, 1884: "*Critique de la loi de Weber.*"

M. Delbœuf, who shows, in reply to the objections of Hering, that in different cases in nature, the relations between cause and effect are far from simple, has thrown great light, by his experiments on fatigue, upon the true character of the psycho-physical law, and the bearing of the natural causes which limit it.

There is in Fechner a very marked tendency to neglect the biological conditions of excitation and sensation. He reasons altogether as a physicist. Yet a sense organ in activity is very different from an instrument in use. When it receives a series of constantly increasing excitations, it is not exactly the same to the second as to the first, to the third as to the second. Among Fechner's critics no one has brought this out better than Delbœuf. The intensity of the sensation, says he, does not depend alone upon the intensity of the exciting cause, but also on the quantity of sensibility or force that the organs in exercise possess at the moment. This quantity or store of sensibility is continually drawn upon and diminished by the excitation.

Consequently, at the time of a subsequent excitation, equal or unequal, the feeling subject is in new conditions. The excitation acts, so to speak, upon another individual. According to the formula of Fechner the sensation grows indefinitely, while the excitation also grows indefinitely; this takes no account of the alteration which the organ undergoes in consequence of the excitation.[1]

"To sum up, every excitation produces a double effect: it is the cause of sensation and the cause of exhaustion, and the exhaustion diminishes the sensation. The sensation is at its maximum purity when it exceeds the fatigue most (the author has determined the value of *d* that gives this maximum). On one or the other side of this value, the judgment begins to grow uncertain."

IV. Wundt, takes up the study of the psycho-physical law again and again. In a recent profound criticism he compares the formulas of Weber and Fechner, notes their points of difference, and inquires to what extent the second is contained in the first. (*Philosophische Studien*, II, brochure I.)

T. H. Weber summed up the results of his experiments in these words: "By the comparison of external impressions, we can discover their relations, but not their absolute values." Wundt considers the law of Weber, with the formula below, applicable to intensive sensations only: "The difference between two excitations, must, in order that the differences in sensation be equally appreciable, grow proportionally to the magnitude of the excitations." The form

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[1] *Étude psychophysique*, p. 29, etc. M. Delbœuf seeks to determine the formula of fatigue or exhaustion: if the excitation be represented by *d* and the quantity (mass) of free sensibility by *m*, he has:

$$f = K \log. \frac{m}{m-d}$$

His research has tended, ever since, to modify the formula of Fechner.

in which the law of Fechner approaches nearest that of Weber is this: "The difference between two excitations must, in order that the differences in sensation be equal (equal, instead of equally appreciable), grow proportionally to the magnitude of the excitations." In its mathematical form, if R represent any excitation, ΔR its smallest perceptible increase, the law of Weber is:

$$\frac{\Delta R}{R} = \text{Constant.}$$

And the law of Fechner:

$$K \frac{\Delta R}{R} = \Delta E,$$

ΔE representing the constant difference of sensation, and K being a constant whose value depends on the rate of increase of the sensation.

The transformation of the law of Weber into that of Fechner rests, primarily, on the supposition that sensation in general is measurable: and objections are brought especially against this position. Kries, in a special study, published in the *Vierteljahrsschrift für wiss. Philosophie*, VI, 257, does not share the popular prejudgment that psychic magnitudes are not measurable; yet he maintains that no rule of measure can be applied to them. For our situation is this: while we have standards of measure, the units that make them up differ from each other, and we have no means of reducing them to a single type. All physical measures are of space, time, and mass, and it is a necessary condition that these three be clearly distinguished. One of these must always be employed, and its units are always the same. But it is not so for the measurement of intensive psychic magnitudes. In a series of sensations e, e_1, e_2, etc., we can not say that the change from e_1 to e_2 equals the change from e_m to e_n, for there is no equality here. We can not infer that the change from an impression of 2 pounds to 3 is equal to the change from 10 pounds to 15.

On the other hand, Boas (*Pflüger's Archiv*, XXVIII, p. 566) maintains that different luminous intensities are no more comparable than different sense qualities, from which he infers that intensive differences are only a form of *qualitative* differences. In short, notwithstanding points of disagreement, Kries and Boas rest upon the pretended impossibility of comparing changes in sensations which are of different degrees of intensity.

Let us examine the conditions of physical measurement more closely, replies Wundt. We remark ordinarily that all time measurements suppose invariableness of duration in the regular natural phenomena that we measure (rotation of the earth on its axis, &c.): but this invariableness does not exist in an absolute sense in any physical movement. We suppose in natural law, also, an invariableness that never exists. We can not compare two quantities of time, like two quantities of space, by superposing them one upon another; while the measure of space rests upon direct intuition, we must have for time, and, consequently, for mass, velocity, force, &c., besides intuition, the foregoing hypothesis of invariableness. Wundt then examines the case of intensive magnitudes that are transformed into extensive magnitudes of space and time, as is the case in the measurement of sonorous and luminous intensities. The process rests upon the hypothesis that a determined law of nature, which presents a phenomenon of objective movement as a function of determined special conditions, is valid; for example, the active force of light vibrations as a function of the distance from the source of light. Besides this hypothesis, there is another, of a psychological nature, that is implicitly admitted: that the conditions of consciousness are sufficiently constant to admit a valid determination of the equality or inequality of sensations at different times.

Psychic measurements are most frequently measurements of intensity: their first characteristic is this essential point, that they are not concerned as much with the equality as with the inequality of sensations. This is the capital point—the source of all the difficulties raised; for the measurement of unequal sensations seems, at once, to contradict the fundamental condition of all measure. But it only appears so. What we compare is really not two sensations, but their difference, and the judgment is, after all, one of equality. In truth, this judgment bears, not directly on differences of sensation, but on the degree of perceptibleness of this difference. Yet the judgment "two differences in given sensations are equally perceptible" is undoubtedly a judgment of equality, as the judgment, "two spaces, two durations, two luminous or sonorous intensities are equal," is such. If it be objected that we measure, not the sensations themselves, but simply their degree of perceptibleness, we reply that here, in fact, the ultimate psychic elements are reached, which alone are measurable in this case. To put the question under any other form, is to put it wrongly, and it is not astonishing that it can not be solved.

This principle of psycho-physical measurement, moreover, can not be restricted to the law of Weber. It finds legitimate application in researches on the sense of place, time, the area of consciousness, &c.

On what condition, then, can Weber's principle of measurement be applied to the law of Fechner? This reduction is possible "only when the differences of sensation compared belong to changes taking place in constant conditions of space and time, and in a series belonging to one and the same sense." This induction supposes, moreover, that "the state of attention being constant, equal changes in perception respond to equal changes in its cause."

These considerations afford an answer to this question: what relation does the law of Weber sustain to that of Fechner? The law of Weber does not relate to sensation itself, but to the manner in which we experience it; it is not a law of sensation, but of perception. The law of Fechner, on the contrary, is characteristically a law of sensation. Strictly speaking, therefore, we cannot say that the law of Weber is the same as that of Fechner: for this is to ignore absolutely the process of sensation, considered independently of apperception.[1]

We have given only a very summary view of the criticisms which have been addressed to Fechner, neglecting objections to details, and giving only the essential points. A complete exposition would fill a large volume.[2]

In replying to them, the founder of psychophysics yields only in points of detail, and, trusting in the durability of his work, closes with a *Nachwort* like this; it is very good:

"The tower of Babel was not finished because the workmen could not agree as to the method of constructing it; my psycho-physical monument will remain, because the workmen cannot agree as to the method of destroying it."[3]

Yet Fechner has this confidence all to himself, for, according to the remark of M. Delbœuf, "though he has many admirers, there are few adepts—and he has against him both his declared adversaries and his more or less faithful disciples."

If we attempt, from all these criticisms, general and partial, to gather some conclusions, the first that arises is that the law of Fechner seems rather to be a *physical law*. According-ing to an hypothesis of which we have hitherto said nothing, but to which our author attaches the utmost importance, between the excitation, a fact entirely external, and the sensation, a fact entirely internal, "an internal physical activity" must be intercalated, to which the name psycho-physical movement is given. Fechner affirms very clearly (*Elemente der Psychophysik*, vol. II, p. 377, etc.), that it is impossible to know the nature of this psycho-physical movement. But that matters little; in physics, we do not know the nature of electricity, but this does not hinder the progress of the science of electrical phenomena. In truth, this hypothesis of Fechner has only one object: to explain the fact that the sensation is not proportional to the excitation. In its relation to the external, psycho-physical force would conform to the universal principle of the proportion of cause and effect. In its relation to the internal, it would be subjected to a certain law of progression. Like all the metaphysical solutions of nature in its twofoldness, this explains none of the difficulties; so it has been universally condemned.

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[1] In regard to apperception, we can only refer to what the author says in his *Physiolog. Psychologie*, 2d edition, p. 351, etc., and to chapter VI. below.

[2] The most recent and complete is by G. E. Müller, *Zur Grundlegung der Psychophysik: kritische Beiträge*, Berlin, 1878, 440 pp. in 8vo. See also the critical study of F. A. Müller: *Das Axiom der Psychophysik*, Marburg, 1882.

[3] *In Sachen der Psychophysik*, p. 215.

This psycho-physical *tertium quid* rejected, the effect is placed beside its cause, the sensation beside the excitation, and as, in most cases, there is a manifest disproportion between the growing intensity of the one and the other, it must be attributed to the physical expenditure of which we have spoken above. The law thus takes on a physical character. The experiments of Dewar and Mackendrick, published in the *Transactions of the Royal Society* of Edinburgh (1873),[1] relative to the physiological action of light, afford, moreover, strong presumption in favor of this mode of interpretation. According to these researches, the intensity of the nerve current transmitted by the optic nerve to the brain is proportional to the logarithm of the excitation of the retina. Here is "a concordance, as the experimenters point out, with the law of Fechner which cannot be regarded as accidental."

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[1] See also Fechner, *In Sachen, etc.*, p. 275, etc., and Mind, No. IV, p. 463.

But if this law has a physical character, has it no interest for psychology? This conclusion seems inadmissible. The study of perception is of capital importance; it is perhaps the key to all the rest. If we are to be limited, as the "internal" psychologists say, to the study of the fact of consciousness alone, then the psychology of perception would be very brief, and would contain about as many errors as truths; for the consciousness of the adult mistakes fatally mediate knowledge for immediate, and acquired for innate. Objective experiment is indispensable here. Only the study of the physical conditions of perception can give its precise nature. The fact of consciousness reduced to itself, disengaged from its setting of material conditions, would remain so abstract, so vague, that it could be no longer distinguished from some of the states of consciousness, for example, from memory. It is only by an illegitimate process that a separation can be established between elements that reciprocally imply and suppose each other. All the results of the experimental sciences have not indeed equal importance for the psychological theory of perception, although there is perhaps not one that is entirely without value; but the facts brought to light by psychophysics can be numbered among those that contribute most.

Wundt, who has recently declared for the *psychic* nature of the law, sees in it "the mathematical expression of a logical phenomenon." According to a theory of his own to be explained elsewhere, all the activity of thought (conscious or unconscious) can be reduced to a logical process,—to inference. In this case, the logical process takes a more definite mathematical form. A more certain interpretation than this is that the psycho-physical law is a new proof of the relative character of our knowledge. It shows that in sensation we have no measure of absolute magnitudes, that to perceive two sensations is in reality to perceive a *difference* between two sensations.

This law, whatever its nature be, conducts also to another result that is worth attention. During the last century, the great effort of the analytical psychology has been to show that, contrary to the prejudgments of common sense, perception does not give a copy of the external world. Between qualities in the object and states of consciousness in the subject, there is only a correspondence; these qualities are signs that the mind interprets and groups after its own nature. The psycho-physical law shows that this is true also in the order of *quantity*. It teaches that there is no equality or equivalence between variations of objective intensity (excitation), and variations of subjective intensity (sensation); that our knowledge consists still in an interpretation only, made by the mind in accordance with its nature. So Fechner appears to have inaugurated in the quantitative study of perceptions, a line of work analogous to that which, after Locke, Hume and Berkeley pursued in their qualitative study, and to have arrived at results analogous to theirs.

We have little to add to this general exposition of Fechner's law and its nature. The preceding criticisms, when brought together, are:

1st. That under its mathematical form it cannot be accepted;

2d. Observation and experiment show that, generally speaking, sensation grows more slowly than excitation;

3d. Though it be verified, within certain limits, for visual and auditory sensations, it is contested for pressure, and does not hold for the other sensations.

To every question as to the value of the law of Fechner, it may be replied roughly: it is the result of work so far done, and for the present, no definite judgment is possible. Whatever become of the work of Fechner, his will remain the glory of having put in new form the old question of the relation of the physical and the mental, and of having brought out, like every original spirit, among his adversaries and admirers, works of verification and investigation, efforts, attempts in all directions, which will not have been made in vain.

ADDITIONAL NOTE.

The possibility of measuring psychic facts (not their *duration;* this will be spoken of later in the volume) having raised many objections, as we have seen, it will not be without profit to look at a recent article of Wundt's, written in reply to the criticisms of Zeller on this subject (*Philosophische Studien;* Heft. 2, p. 251 and fol.).

Under this title, psychic measurements, E. Zeller read March 3d, 1881, before the Academy of Sciences at Berlin, an article in which he discussed the question whether psychical facts are capable of measurement, and, if so, under what conditions. He reaches, on the whole, a negative result, although in the end he recognizes the psychological importance of Weber's law, which rests, nevertheless, upon such measurement.

Zeller is disposed to relate the law of Weber to the general principle of the relativity of psychic states, realized particularly in the domain of sensibility (including the feelings).

The objections of Zeller, says Wundt, to the idea of the measurement of psychic phenomena, can be reduced to two points, one of which is, as it were, speculative, and the other empirical. They are these: Psychic facts are not measurable: 1st. Because every attempt to measure them contradicts the conditions that all measurement must fulfill; 2d. Because, in fact, all attempts to do this have failed. Let u examine these two points.

Psychic facts, says Zeller, are known to us only throug consciousness; they can then be compared only with an measured only by other facts of consciousness. But wha unit of measure is to be employed? When we compare tw states of consciousness, the first is the standard to which w refer the second. Every attempt at measurement gives onl a determination of a relation that is always variable and incapable of numerical expression. When we say, for example, that we have been well amused, we express ourselve through the memory of the way in which we are ordinarily amused. But there is no possible reply to the question: How much does one amusement surpass another? Further, all changes in nature are movements, simple or in groups, and are, as such, reducible to space magnitudes, that is, to irreducible elements; but since the facts of consciousnes are not reducible to movement they are not reducible to measurement.

With similar reasoning, says Wundt, we might maintain from a philosophic point of view that all external natural phenomena are not measurable: and yet it is upon such measurement that physics and mechanics rest. We might say with reasoning similar to Zeller's: Every phenomenon is measurable only by a similar phenomenon. Sensation is our only means of knowing the external world. Sensation is a state of consciousness differing wholly from mechanical movement. Therefore every attempt at measurement is an illusion.

These two arguments rest in the same sophism. They are a part of the fiction that there is a world within us and a world without us, and that these two worlds meet at their limits, but have nothing in common. Purely fiction, since the external world is made up of representations to which we attribute an external value; and the internal world is made up of the same representations with their subjective, changing conditions, of feeling, and accompanying volition. The physicist can then reply in all security: Physics seeks to measure objective representations by objective representations; it measures like by like. The psychologist can reply in like manner: Psychology seeks to measure representations by representations, and, if it measures purely subjective representations by objective representations, the latter do not cease for all that to be representations, and consequently there is still a sufficient sameness between the objects measured.

We now reach the second position of Zeller. It can be stated in two points: 1st. No absolute measurement can be reached in the domain of psychic facts; only relative measurements can be determined; 2d. These latter cannot be formulated in numbers, and consequently they also are impossible.

No psychologist flatters himself that he can establish absolute constants in his science, like the constants of weight, electro-static and electro-dynamic units, etc. Psychological facts are too complicated for this. But even admitting that the absolute measurement of a psychic fact can never be possible, still the possibility of a numerical measurement will not be excluded. Zeller himself acknowledges this in a certain sphere, sensation, when he remarks that the law of Weber exhibits a measurement of psychic states which is entirely relative. But the law of Weber was not discovered by philosophical speculation or internal observation, but by experimental measurement, and is itself expressed in number. How can Zeller be reconciled with himself, when he not only accepts this law, but extends it throughout the whole domain of sensibility?

Moreover, he adds, all measurement of this kind pertains only to the *intensity* of sensation. The *quality* has hitherto remained inaccessible, and always will remain so. The only exception is the calculation of musical intervals, which are based upon qualitative marks. This reasoning, replies Wundt, is not clear: We must understand, by the "measurement of psychic facts" either an immediate tendency of consciousness to compare its states in view of measurement, and then the case cited is an example, in whatever the difference of musical intervals consists; or an experimental process, and in this case the theories of which Zeller speaks are based upon results arrived at by processes of measurement. So it is entirely erroneous to maintain that these processes are not applicable to other sensible qualities, for example, sensations of color.

Zeller has not seen fit to speak of the investigations relating to the complex processes of perception. Yet here also, as in the case of elementary psychic facts, the question of measurement is agitated. In the theory of vision, for example, investigations of the relation of the smallest movements of the eye to the acuteness of vision, of errors in the estimation of distance and direction, of the quantitative conditions of visual illusion, are important. Yet all these are psychic facts: and the investigation of the quantitative changes that these phenomena undergo through the variation of these objective conditions requires, as Weber's law requires, the employment of measurement in the domain of psychic fact.

CHAPTER VI.

WUNDT.

Physiological Psychology.

I.

WUNDT is considered, at the present time, the principal representative of experimental psychology in Germany. He alone has treated it in all its area. Fechner, though his work was so original, was confined to a single question; Lotze was essentially a metaphysician and often seemed to enter the domain of experience by necessity and with regret; Helmholtz, despite the great value of his analysis of elementary sensation, is a psychologist only on occasion; and others, who are following in Wundt's footsteps, are still far behind and can not overtake him. He alone has made a complete and systematic study of the problems of psychology from this standpoint.

In 1862, in his *Beiträge zur Theorie der Sinneswahrnehmung* (contributions to a theory of sense perception), he studied, in the form of monographs, many questions relating to the physiology of the senses, of sight in particular. Since then his publications have treated either of pure physiology, as the *Medicinische Physik*, the *Lehrbuch d. Physiologie d. Menschen*, and the *Untersuchungen zur Mechanik der Nerven u. Nervencentren* (1871–1876), or of physiological psychology, as *Vorlesungen über die Menschen u.*

Thierseele (1863), and especially the *Grundzüge der physiologischen Psychologie* (2d ed., 1880).[1]

The unity of his work arises from his method. It is based on the data of physiology: directly it deals with sensation considered distinctly as the basis of all psychology and the food of the mental life, and, further, with involuntary movement, language, the lower forms of feeling and their natural expression; indirectly, it deals with the will, attention, complex notions of space and time, the æsthetic feelings. Where physiology fails, anthropology, ethnography, history, statistics, afford a foundation. In short it differs *in toto* from both the speculative method and its near relative, the method of internal observation.

Psychology must be treated, then, as a natural science: for this it must be exact. "More than once in late years," says Wundt, "has psychology been treated from the point of view peculiar to the natural sciences, but we must admit that these attempts have made no real progress on earlier speculative systems. For psychology, even when considered as a natural science, has looked to *internal observation* as its only help. Now nothing has been added since man first began to think and reflect, to the facts of consciousness found by observation in the bosom of every one; the science has added little to the familiar experience of the whole world. Thanks to this method, psychology has remained for centuries the same; what is scientific in it can scarcely be separated from ordinary experience."[2]

The first object to be desired is the transformation of psychology into an *explicative* science. If we examine the earlier or even the actual state of the sciences of the phenomena of nature, we find that some simply *describe*, while others *explain*. The more a science is advanced, the less it describes: or, at least, the less it confuses description and explanation. "Thus most of the works of empirical psychology belong to the natural history of the soul. The recent profound studies in the psychological interpretation of history and ethnography belong in the same category, though in a larger sense. For the psychology of peoples deals with phenomena so complex, that they can be explained only by the facts and laws of the individual consciousness. Here, above all, is a work of classification of a peculiarly descriptive kind."[1]

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[1] Wundt has also published a *Logik*, a large work in two volumes, and many memoirs on psychological questions, of which we will speak incidentally. (None of these have been translated into English.—Tr.)

[2] *Menschen u. Thierseele*, I, Vorrede, p. 5.

Wundt, on the contrary, proposes a work of explication. To do this, it is necessary to add *experiment* to the internal observation which, alone, gives description only; and with this *measurement* must also be employed. This is the object of physiological psychology. It starts with physiological facts and seeks to discover the elementary psychological facts which are connected with them. Our point of view, says Wundt, is not that of internal experience. We begin, on the contrary, without and seek to penetrate within: and to do this we employ means altogether peculiar to natural science, i. e., the experimental method. In truth, this method can be employed only in the domain of psycho-physics; or more exactly, it employs experiments that are psycho-physical and not purely psychological. Yet, as this method consists in varying the external conditions that are necessary to the production of internal phenomena, it follows that we have in this a doorway to internal phenomena. In this sense, every psycho-physical experiment is at the same time a psychological experiment, and within these limits experimental psychology is possible. Thus the end is to construct psychology; physiology is but the means. This is the meaning of the term physiological psychology.

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[1] *Physiolog. Psychol.*, Introd., p. 5. All quotations are made from the second German edition.

Further, we will allow the author to explain the course which he intends to pursue:

"When we enter a little further into the question, we see that the traditional opinion that consciousness is the entire field of the internal life can not be accepted. Everywhere in nature, the object of all immediate observation is phenomenal and complex: the laws by whose action the phenomenon is realized, remain hidden from our sight. Is psychology the one exception? Must we admit that psychic laws are within the reach of immediate perception? What, then, are the reciprocal relations of these laws? In consciousness, psychic acts are very distinct from one another: desire, feeling, sensation, idea, are given us as distinct modes of activity. Must we give to each of these activities a separate sphere? This is the current doctrine of fundamental faculties of the soul. But a science is still in its infancy, whose task is simply to show differences among the objects of its analysis. The full-grown science tends to unity. And observation itself necessarily conducts to unity in psychology. But the agent of this unity is outside of consciousness, which knows only the results of the work done in the unknown laboratory beneath it. Suddenly a new thought springs into being: we know not whence it comes, for the conditions which produced it have already disappeared. Ultimate analysis of psychical processes shows that the unconscious is the theatre of the most important mental phenomena. The conscious is always conditioned upon the unconscious.

"How can we descend into this secret laboratory where thought has its hidden spring? How separate the thousand threads that make its tissue? The investigations that follow are intended to show that experiment is, in psychology, the necessary guide to the hidden foundation where the conscious life has its rise. Internal observation, as observation in general, gives only complex phenomena. By experiment, on the contrary, we strip the phenomenon of all its accessory conditions. The phenomenon is produced artificially, in given conditions, which we can change at will, and measure. Everywhere and always, experiment conducts to natural law, because it exhibits cause and effect simultaneously.

The naturalist begins with the observation of phenomena given immediately in nature: the psychologist begins, in the same way, with the facts of consciousness. When, by this means, he has resolved psychological phenomena into simple elements, he casts a sly glance also upon the mechanism that elaborates, in the unconscious depths of the soul, the impulses derived from external impressions. The naturalist pursues the same path. When from the entangled phenomena which observation gives he rises to the laws that rule them, he reaches evidently the hitherto unknown foundation of these facts. The process below consciousness whence the conscious act proceeds, bears the same relation to this act as the concealed law bears to the phenomenon given in sensation.

"Experiment is accompanied by *measurement*, step by step. Weight and measure are the great instruments of experimental research, and are always employed in the search for exact laws. With experiment, weight and measure enter into the science: for they give it a definite character. Measurement reveals the *constants* of nature, the laws that regulate phenomena. The results of all measurement are expressed in number. Numbers are not the object of measure; but they are the indispensable means of arriving at its true object, for only numbers can reveal law.

"But, it will be asked, how is it possible to apply experiment to the psychic principle which is entirely distinct from sensation? The principal cause of the phenomenon escapes sense; so experiment reaches the phenomenon only. Although the effects and conditions of the psychic life alone are accessible to our investigation, yet these effects and conditions, if they are sufficiently analyzed, bring us to the ultimate essence of the facts which constitute the psychic life. By the senses and by movement of the body the soul sustains a continual relation to the external world. We can apply external agents to the senses and produce movement at will, observe the effects, and from these effects draw conclusions as to the nature of the psychic processes. Our measurements never apply directly either to the efficient causes of the phenomena, or to the efficient causes of the movements: *we can measure them only by their effects.*"[1]

II.

SENSATION.

The author has treated of the anatomy and physiology of the nerve system at length, and collected in some detail[2] the most recent views on this subject. He falls back upon the work of Meynert, and shows that the anatomy of the spinal cord, medulla oblongata, protuberance, peduncles, cerebrum and cerebellum, reveals the psychological functions of these different organs, and indicates the difficulties to be met at every turn of this subject.

With the study of sensation, he enters into the subject proper: "If we begin with the study of the simplest psychological phenomena, we must confess that their ultimate elements always escape our observation, or are found connected with other phenomena. Yet of them all, pure *sensation* certainly presents the greatest simplicity. By this we mean the primitive states which man finds in himself, isolated from all the relations and connections that the adult consciousness gathers round them." Sensation must be distinguished thus from *perception*, a phenomenon which is much more complex, and which must be studied apart.

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[1] *Menschen u. Thierseele.* Preface.

[2] *Grundzüge*, I, pp. 19–264.

Placed in this degree of isolation, sensation presents two immediate determinations only:

1st. It is strong or feeble; it has a certain *intensity*.

2d. It has a characteristic mark, which differences it from everything else; it has a certain *quality*.

3d. Finally, it has a third characteristic, less clear than the two others. In a real sensation, there is something which belongs to the thinking subject: a secondary state accompanying the primitive sensation, which may be called a *feeling*. Especially in sight and hearing do we notice these concomitant feelings. They are the elementary factors of the æsthetic effect. They exist also in touch, taste and smell. This is the *tone* of the sensation.[1]

The two first mentioned are primitive elements: if we suppress them, the third disappears.

INTENSITY.—We will not take this question up again, as it has been already discussed at length under the psychophysical law.

QUALITY.—By quality, we understand the element of sensation that remains if we suppose the intensity suppressed. Under relations of quality, sensations may be divided into two great classes:

1st. Sensations qualitatively uniform, presenting *one* determined quality, but having all possible degrees of intensity. Such are the organic sensations, the cutaneous sensations (pressure, heat and cold), and the muscular sensations. The last are further divided into two classes: sensations of innervation, *i. e.*, of the expenditure of muscular force in movement; muscular sensations proper, caused by the state of nutrition, fatigue or lesion of the muscles.

2d. Sensations qualitatively different; those of the four special senses: hearing, sight, taste, smell. Each species is made up of a combination of different qualities, of which each may have different degrees of intensity.

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[1] German, *Gefühlston*.—Tr.

We may suppose that qualitative differences depend immediately upon differences of structure. In this connection, Wundt enters into the histological study of the terminal sense organs: for smell, the olfactory cells between the epithelial cells that line the mucous membrane of the nose; for taste, the calicular, fungiform, and filiform cells; for sight, the different coatings of the retina; for hearing, the fibres of Corti; for touch, the corpuscles of Pacini, Meissner, and Krause.

The excitation, acting upon these terminal organs, gives rise to a movement which is transmitted to the nerve centres. But this is done in two distinct ways. In the *mechanical* senses (touch and hearing), the external excitation is transmitted in the nerve substance in a way very probably peculiar to itself, and by a process that corresponds, in general, to that of the exciting movement. In the *chemical* senses (sight, taste, smell, temperature), the external excitation gives rise to a nerve phenomenon entirely different from itself, both in its form and its process; although, within certain limits, it changes according to the variations of the excitant. In the first case, there is a direct transmission of the external movement. In the second, the excitation produces a fact of a different nature, probably a chemical molecular movement. Thus it may be said that the excitation is felt *more immediately* in the first than in the second case; in the latter, the form of the excitation depending, in the highest degree, upon the molecular constitution of the nerves, which is unknown. The mechanical senses are evidently the simpler; and the most general of all, touch, serves probably as basis for the development of the four special senses.

Wundt places sight among the chemical senses, though recognizing the difficulties which this classification involves: he explains in detail the reasons which lead him to put this sense with taste and smell. From the first, the excitation is changed in the retina to another form of movement. "We can not at once define the transformation that takes place here, but it seems proper to call it a *chemical action*. On this supposition, we can account for the easy chemical decomposition of the nerve substance and the chemical action of light in general. In the lower forms of the organ of vision, the photo-chemical action seems to be followed by the absorption of the most refrangible luminous rays. These lower forms consist of nerve fibres in connection with epithelial cells containing a red pigment. The same process of absorption takes place in the retina of birds, since we find inside the cones touches of red and green pigment." It is to be remarked also that the diversity in sensations of light cannot be explained by the simple differences of degree in the action of different luminous rays upon the retina: instead of different colors, we would see different degrees of light intensity only. There must be then other differences in the chemical effects of luminous excitations, differences whose nature we can not determine. Further, sight presents this remarkable property, that all differences in the form of the excitation disappear when it is very strong or very feeble; luminous excitations of all kinds are perceived as black if they are very feeble, as white, if very strong. Only medium intensities produce clear photo-chemical action. And differences of photo-chemical action answer to differences of sensation, as each species of ray acts in a different way upon the chemical combinations of the nerve substance.

Another question, of very general import and much discussed, is that of *specific nerve energy*. It offers a special philosophic interest, since it has been brought forward by many writers as the physiological expression of Kant's doctrine of the subjectivity of knowledge. If we admit the theory of specific nerve energy, the quality of the sensation becomes a function of the substance of the given sensor nerve. When we have sensations of light, sound, heat, &c., it is not the external impression that is reported to consciousness, but the reaction of the sensor nerve upon this impression. This doctrine rests upon the fact that each nerve is sensitive to certain determined excitations only (the optic nerve to light, the acoustic to sound, &c.); and that if we employ an excitant of a general character (electricity, &c.) each nerve reacts in its own specific form.

There are several difficulties in the way of this solution, and one of them is capital. This is the functional indifference of the nerves. To avoid it, specific energy is attributed exclusively to the terminal organs and brain. The nerve fibres, to cite a comparison much used, are like telegraph wires, which produce very different effects (ring a bell, move a magnet, &c.) according to the point with which they connect. Yet since the terminal organs have simply a power of transmission through the nerves, and this does not give rise to sensation, it is the brain distinctly to which the specific energies are to be attributed. Moreover, if indeed we allow the terminal organs a part in the phenomenon, still the internal differences that arise as signs answering to peripheral differences must be located in the nerve centres, since the specific sensations come into being even after the ablation of the sense organs. There are reasons for extending to the central terminations of the nerves the principle of functional indifference. The differences they present are certainly not as great as those of nerves of different kinds, and yet these, as experiment shows, can be indifferently motor or sensor. It is then a subterfuge merely to make the nerve centres the seat of specific functions; for these centres are not well known and one can say of them what he please.

The difficulties that this doctrine encounters are greater still, if we attempt to explain by it the qualitative differences of sensation in one and the same sense. Let us take light. According to the hypothesis of Young, adopted and modified by Helmholtz, there are three kinds of nerves, sensitive to red, green, and violet light. But since a luminous impression is confined to an extremely small point, and never has a definite color in perception, it must be maintained that there is an intermingling of these three kinds of nerves on very small portions of the retina: an hypothesis difficult to believe considering the diameter of the rods. Each seems to have only a single fibre. With sensations of sound, the difficulties are still greater.

The two ways in which excitations undergo change in the nerves may be represented in a general manner. In the one case the nature of the molecular phenomena does not change, while the periodic vibrations increase and decrease in amplitude (sound). In the other case, the nature of the molecular phenomena does change, according to the kind of excitation (chemical senses). In the two cases it is admitted that the molecular phenomenon is transmitted just as it enters, throughout the entire nerve, to the brain; that the processes in the central cells are different, and through them different sensations are reported to consciousness. This is the only way to accord the fact of functional difference in the organs with the principle of functional indifference in the elements. On this hypothesis the nerve elements have no longer specific functions, for every change in the nature of the molecular phenomenon arises from the manner in which the elements come in contact among themselves, and in the organs of sense, with the external excitation.

"The point that essentially distinguishes the hypothesis of specific energy from the foregoing is this, that the former supposes the sensation to be determined exclusively by the *parts* over which the excitation runs, while to us the *form* of the phenomenon is the immediate ground of the form of the sensation. It is hardly necessary to show that this opinion, even from a psychological point of view, is more reasonable. It can indeed be maintained that consciousness is determined qualitatively by the nature of our organic processes; but that these qualitative differences are connected with local differences of process alone, is very difficult to conceive."

The theory of specific energies, as Wundt remarks, is a physiological echo of the philosophy of Kant, of his attempt to determine the subjective conditions of knowledge: this is very clearly shown also by J. Müller, one of the principal representatives of this theory, in his *Elements of Physiology*. But there is no bond of logical necessity between the two doctrines; and the purely subjective view of the nature of sensation leaves the field free as to its physiological foundation. It is evident also that the discussion of this theoretical point does not involve the established relation of sensation to external excitation.[1]

It still remains to speak of the feeling that accompanies sensation; but this question will be postponed until we treat of feeling in general.

III.

PERCEPTION.

Sensation is the content of representation. Compared with sensation, representation is a complex fact; sensations are its constituent elements and it results from their combination. A representation that relates to a real object is called a *perception*. If it relates simply to an object in thought it is a *concept of the imagination*. Only the first engages our attention.

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[1] Wundt explains at length the facts and physiological problems that belong to hearing, considered as type of the mechanical senses and to sight as type of the chemical. He also has a very interesting criticism of Young's hypothesis of three primitive colors, vol. I, p. 640, &c.

It would be impossible for us to follow Wundt in his long study of tactile, auditory, and visual perception, conducted as it is on his method and involving many physiological results. We will only attempt to expound a single point, that in which he is most original; the answer to this question: How are our tactile and visual perceptions localized in space?

We have seen that there are two theories on this point in Germany: those of innateness and experience. Wundt adopts neither the one nor the other.

Neither of these theories, says he, is sufficient. The theory of innateness maintains with reason that anatomical dispositions are of the first importance, that experience exerts only a very narrow influence, that variableness, indeed, finds its cause in the physical organism. But it is too hasty in drawing the conclusion that since the conditions are innate, the perception of place is innate also. Nor can we refuse to accord, with the empiricist, a very large function to experience; but there is no proof that the perception of place arises from it alone. If we attempt, by a sort of eclecticism, to unite the two theories, we commit at least a new error, since, if we maintain that the perception of space is given to a fixed degree, we must still maintain that experience determines it. If we intrench ourselves in the hypothesis of an entirely indeterminate localization, related to real space only in experience, we place ourselves in manifest contradiction with the very idea of localization, since this implies relation to definite points in space.

The theory of Wundt, as we have already indicated it, and are now about to expound it in detail, can be summed up at the outset thus: Each point of the skin (in touch), each point of the retina (in sight), has a local sign, a peculiar and especial kind of sensitiveness to impressions: this is the beginning of localization. Further, these different impressions are accompanied by movements, and consequently by a certain feeling of innervation, varying according to the member and place affected. Neither local impressions alone, nor movements alone, can give localization in space; but these two elements, united by a sort of mental chemistry, by a psychological synthesis, form a combination which is nothing other than the notion of space.

Let us first examine touch on this hypothesis.

Sensations of touch, pressure, and even of temperature, are referred to points of the skin. But this localization is not always made with the same degree of precision.

Weber first brought exact and minute research to bear upon this point. It has been continued since. By employing the two methods, of smallest perceptible differences and true and false cases, the relative delicacy of the *sense of place* in different parts of the body has been determined.

Moreover, it is easy to show that the skin is not equally sensitive in all its parts. If we touch the cheeks and then the palm of the hand with one finger, exerting each time the same pressure, the sensation seems, notwithstanding, different in the two cases. It is the same if we compare the palm and the back of the hand, the chest and the back,—in a word, any two parts of the skin distant from each other.

And we find, on close observation, that two points nearer together on the epidermis, still differ as to the nature of the sensation produced. If we pass from one point of the skin to another, we find that there is a successive and continued change in the sensation, although the external pressure remains constant. Sensations produced at corresponding points of the two halves of the body, although analogous, are no nearer alike. And we can not believe that these differences come simply from our representing the sensations compared as produced at different points. No: proceeding with great attention and considering the nature of the sensation only, independently of all consideration of place, we find the difference as great as before. It is admitted, then, that each part of the skin has a determined local characteristic, which gives to the sensation a quality due to the place at which the impression is produced. The quality of this local characteristic varies from one point of the skin to another, in a continuous manner, and in such a way that we perceive these differences only when the distances are sufficiently great. If the external impression is intense (yet within the limits of the painful), the local characteristic is very clear. It is admitted also, as has been indicated, that symmetrical parts of the body have local characteristics that are very analogous, but not identical. This hypothesis rests on evident analogies in anatomical structure and on other physiological facts.

The local cause of these differences of sensation must reside in the peculiar nature of the sense organ, that is, in small constitutional differences; or in the disposition of the nerve endings. The result is that we recognize the place of an impression, provided we have already had experiences at this point.

It remains to examine the second element in perception, concomitant movement. Its influence is very great in the direction of exactness of localization. The easier the movement of the part of the body, whatever sense be affected, the more precise is the localization. According to the investigations of Kottenkamp and Ullrich, the sense of place decreases in delicacy continuously from the end of the fingers to the hand, forearm, arm, shoulder. In the leg the decrease is analogous. This has led Vierordt to formulate the following principle, which he calls a *law*: When any portion of the body moves as a whole, the delicacy of the sense of place is always proportional to the distance from the skin to the axis of movement.[1]

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[1] For more details, see Vierordt, *Die Abhängigkeit der Ausbildung des Raumsinnes der Haut von der Beweglichkeit der Körpertheile*, in the *Zeitschrift für Biologie*, VI, p. 53.

Finally, habit has yet a further influence on the exactness of localization, as is seen in the case of those who are born blind. Fatigue or a lowering of temperature makes the sense less delicate. Diseases of the brain and spinal cord modify or destroy it. A patient suffering from æsthesis of the lower extremities felt in the upper part of the thigh impressions made low down upon his leg or upon his foot.

The theory of tactile perception ought to explain the production, in a given organization, according to psychological laws, of an order of tactile sensations in space. All observations show that *movement* is a factor of the greatest importance in this order of perception. Language itself, for example the word "touch," implies movement of the feeling parts. Such an influence of movement upon tactile perception can arise only by means of the sensation of motor innervation.

The feeling of innervation combines in all possible ways with tactile sensations. Tactile sensations arising from pressure upon the tissues of any part of the body are invariably associated with the movement of that part, and there is a constant relation in degree of intensity between the motor and tactile sensations. It is probable that the first notion of place arises from this combination: it is *the differentiation of the parts of the body according to their situation in space.* The more easily these parts can be brought into contact one with another, the more clearly can they be distinguished one from another.

It is clear that when we distinguish the movement of the arm from that of the head, it is by means of a *qualitative* difference in the accompanying sensations. Further, experiment shows that if the sensibility of the skin be destroyed, the notion of the position of our limbs in space is strangely altered, a fact that is explained by the close connection of tactile sensation with the feeling of innervation.

According to a well-known psychological law, different sensations which are constantly associated form a whole so complete, that if part of this whole be excited, the rest is excited also. This law applies to the case before us. In fact, tactile sensations and feelings of innervation form an indissoluble whole. It may be said that we never experience tactile sensations alone, nor feelings of innervation alone; it is impossible to isolate either of them completely.

The process, then, in this case, is a *psychic synthesis*. "We may understand by this expression, the especial combination of peripheral sensations, with feelings of central innervation, whence results an order of first data in space.[1] For the idea of synthesis ordinarily has reference to new properties in the product which were not present in the constituent parts. Just as in the synthetic judgment a new predicate is attached to the subject, and as a chemical synthesis is a combination with new properties, so the psychic synthesis gives, as a new product, *an order of sensations in space*." But psychological analysis can give only the elements of this combination; the order in space, as a synthesis, is as foreign to our analysis as the properties of water are to its analysis into oxygen and hydrogen.

"The local signs of the sense of touch present a continuity of two dimensions, from which it is possible to arrive at the idea surface. But this continuity does not, in itself, involve the notion of space. This latter, we maintain, arises first from a relation of reaction upon the simple continuity of the feelings of innervation. These feelings, by their purely intensive variations, constitute a uniform measure for the two dimensions of the local signs. The form of the surface in which these signs are arranged is at first entirely indeterminate. It varies with the form of the surface that is felt. But the laws of the movement of the members are such that, in most of the changes in position, the organ of touch moves in a *right line* toward or from its object. Since, then, the right line becomes a determining element, tactile space has the form of *plane* space, in which the surfaces which we perceive, and which change as to their curvature, must be referred to *three* right-line dimensions."[1]

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[1] *Räumliche Ordnung der ersteren; Grundzüge*, II, p. 28.—Tr.

The same question arises as to visual space, and Wundt answers it in the same way.

Do we admit that the sensation itself has from the first the form of space? No. In fact, although the sensitive elements form a mosaic in the retina, and a part of this organ, called the *blind spot*, is insensible to light excitations, yet the field of vision is seen as a continuous whole. Now, if this perception of space were immediate, this insensible portion of the retina would appear as a hole or break in the visual field. In experience, however, it is not so.

We meet the same two elements again here: 1st, local signs; 2d, movement, and the feeling that accompanies it.

First the local signs: "If we hold in the hand before the eye a piece of red paper, and then carry it slowly to one side, the eye remaining still, the image of the red object is projected first upon the centre of the retina, and then more and more upon the sides. We notice that while this sideways movement continues, the sensation of red undergoes successive changes; the color becomes first deeper, then a little blue; at last the red object appears entirely black. Analogous changes can be produced with any color, simple or composite. Evidently the explanation of this phenomenon is that the different parts of the retina are differently sensitive."

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[1] Wundt puts the same theory in another form in his *Physiologie d. Menschen.* The perception of space is the result of a *psychic synthesis* whose elements are, an order of peripheral sensations, and the corresponding order of sensations of innervation. In other words: If we suppose a series of local impressions, a, b, c, . . . to be passed through, the passage from a to b, from b to c, etc., will answer to the elementary sensations of movement, α, β, γ . . ., which, during the passage of the series of local impressions to the term x, may be summed in a sensation A. Neither the series a, b, c, . . . alone, nor the series α, β, γ . . . alone, can give the perception of co-ordination in space, or the notion of place. But the perception of space is due to the reciprocal relation of the two series. For more details, see Wundt, *Beiträge zur Theorie der Sinneswahrnehmung*, part 3. *Physiologie d. Menschen*, Fr. trans., p. 518. *Menschen. u. Thierseele*, I, p. 233, etc. *Grundzüge d. Physiol. Psych.*, II, p. 27.

As to movement and the part it plays, Wundt first introduced it as one of the primitive elements of the visual field.

The following are the arguments he brings forward on this point:[1]

1st. Vertical distances appear greater than the same horizontal distances; the relation between them is about 4.8 to 4. This is also the relation which holds between the forces which move the eye horizontally and vertically; a relation that is determined by the arrangement of the muscles.

2d. We can distinguish a difference in the length of two lines when they differ by $\frac{1}{50}$. The difference in the movement of the eye in this case is also $\frac{1}{50}$ of its entire linear movement.

3d. The smallest absolute distance perceptible and the feeblest movement of the eye, to be appreciable, are in exact agreement; they answer to an angle of one minute.

4th. In cases of paralysis of the abductor muscle of the ball, as we have already said, objects seem to be situated farther away. The distance seems longer because the muscular contraction must be greater to execute the same movement. The patient sees an object farther off than it really is, and when he wishes to grasp it, grasps the space beyond. After very great effort, he can accustom himself to it and regulate his movements.[1]

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[1] *Physiologie der Menschen*, Fr. trans., p. 517; *Menschen u. Thierseele.*

So, then, we have in the sensation that accompanies movement, a real measure of the intensity and extent of that movement.

In truth, the process here is the same as in the rise of the order of tactile sensations in space. The local signs of retinal sensation form an indissoluble combination with feelings of innervation whose intensity is variable. The point which distinguishes visual sensations is that this combination is referred to a single point, the centre of the retina. This reference, facilitating the exact measurement of the field of vision and making the functional union of the two eyes, in binocular vision, possible, has its ground in the laws of movement. Inasmuch as these laws belong to an innate central mechanism, we can say that the individual is born with a completely developed tendency to give his visual sensations an immediate order in space. However short be the time that elapses between the first action of the retinal impressions and perception, we must nevertheless interpose a *psychologically* determined fact, by means of which this perception is realized.

For tactile perception, this fact can be considered a *synthesis*, since the resulting product presents new properties, different from those of its sensible components. This synthesis consists in measuring the quantitative variations of peripheral sensation by the intensive variations of feelings of innervation. The eye can move in two principal directions (above and below, to the right and left) and between these, in all possible directions, each position corresponding to a given combination of the sensitive elements. When the eye moves, the image of each point perceived moves also upon the retina; the local signs are modified in a determined way, and thus is formed the notion of a continuity of *two* dimensions. "But these dimensions are not homogeneous, since the local signs are changed in an especial way for each change in direction. The feelings of innervation that form a continuity of *one* dimension, serve to measure, in all possible directions, the continuity in two heterogeneous dimensions, and to refer it to a homogeneous continuity in two dimensions, *i.e.*, a *surface*. Thus the monocular field of vision is formed."

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[1] For more details, see above, chap. IV.

In the case of binocular vision, the combination of the local signs with feelings of innervation is variable. Suppose a sign *a* of the right eye combines with a sign *a′* of the left, both answering to a point 10° left of the point of vision. To this combination *a a′* there will correspond a feeling of innervation of 10°. Now if *a* combine with another sign *a′* only 5° to the left, the combination *a a′* corresponds to another feeling of innervation made up of convergence and conversion to the left. The synthesis here is more complicated, and the fact of perception may be decomposed into two acts: first, that by which the position of a given point *a* is fixed in relation to the visual point, due to the local signs and feelings of innervation of the first eye; second, that by which the position of the visual point and the point *a* is fixed in relation to the seeing subject, due to the added influence of the second eye. If we consider the monocular field of vision as a plane, certain parts of this field may stand out from this plane in consequence of the addition of the second eye. This plane changes into a surface of another form, varying according to the special conditions of the case. To illustrate this by a comparison, suppose—as is the case in monocular vision—a fixed point and a right line proceeding from it, capable of moving in all directions; by means of this twofold apparatus we may construct only one simple surface, a plane, provided the line is infinite. Suppose now—as is the case in binocular vision—two fixed points and two right lines, in constantly varying direction, whose points of intersection can give a surface; by this fourfold apparatus we may obtain a surface of any form whatever.

Remembering that Wundt calls each sensation a conclusion, we may say with him: The synthesis of two series of conclusions (impressions of sense and sensations of movement) in a single conclusion gives space. This synthesis he likens to *chemical combination*. "Just as in chemical synthesis, new properties arise from the combination of certain elements, so the psychic synthesis gives a new product which is the order of elementary sensations in space. And, while the elementary sensations are given us by psychological analysis, the notion of space can not be, because it is the result of their synthesis."

IV.

THE GENERAL NOTION.

Composite psychic forms arise from simple perceptions. They may be divided into three classes: complex notions; general notions; forms of intuition, *i. e.*, time and space.

Notions or complex perceptions are formed by the union of simple perceptions of different kinds. The greater part of our representations belong to this class, since they correspond to real, concrete, complex objects.

General notions are formed from a certain number of simple perceptions which are analogous to one another and agree largely in their elements (example: man, tree). As every psychic state is the more easily reproduced as it has already been the oftener in consciousness, it results that these analogous elements must possess great reproductive force. A sense impression will awake elements that have been already often reproduced. "The laws of reproduction suffice to explain the genesis of the general notion, and there is no reason to attribute it, with the old psychology, to a special faculty of abstraction."

The author distinguishes the general notion from the *concept* (*Begriff*).[1] The concept has no place, as sensation and perception, as a determined psychological form. It has in consciousness a single substitute: a word, spoken or written. This explains the fact that the abstract concept is not found with the animal or young child, while the general notion is. The general notion is, properly speaking, only a schema of the particular notions that it includes. The concept is something more: it constitutes scientific knowledge and gives law to phenomena. It is, says Wundt, a *postulat*. "When we resolve a general notion into its final elements, we see that the more extended this notion is, the more insufficient is its comprehension of the objects entering into the schema. We remark at the same time that however indeterminate in its compass the general notion be before it is resolved into particular facts, still each of the elements it contains may be changed without destroying the general notion. Thus the postulate of a general notion is produced which; 1st, contains the elements common to all the particular subordinate conceptions, and 2d, can be extended, if completely resolved by analysis, to all these particular conceptions. It is a postulate of this kind that we call a concept."

Wundt distinguishes empirical and abstract concepts. The first includes a sum of general notions, just as the general notion includes a sum of particular notions. Common experience alone is sufficient to form it (for example, the concept man); but it is vague, without precision or scientific rigor. An ultimate process of mind forms the abstract concept (cause and effect, means and end, quantity, number, necessity, &c.), so called because they go beyond experience, and are not immediately applicable to the objects of observation, internal or external. The difference in these two orders of concepts is one of degree. "We call a concept empirical which includes a limited group of phenomena; abstract, when it includes several groups."

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[1] *Grundzüge*, II, p. 310, and *Menschen u. Thierseele*, lect. 26–28.

The forms of intuition, time and space, are related to the general notion as well as to the concept. On the one hand, they set out from particular perceptions, since they correspond to the entire impression of the internal (time) or the external (space) order of representation. On the other hand, this order is itself wanting in the representation: time and space are then postulates, as concepts are postulates. They differ, however, in this, that a simple sign can not represent them: they are transformed in consciousness into a particular lapse of time and a particular length of space, which become sensible substitutes for time and space in general; and it is because they are thus connected with particular representations that common sense and the old philosophy, with this in view, considered them independent existences, embracing all things.

Time.—The intuition of time arises from a succession of varied representations, each of which remains disposable in consciousness, when a new representation enters. It consists less in the real reproduction of representations than in the representation of their possible reproduction. Psychologically, this takes place when each representation, disappearing from consciousness, leaves a trace, a certain effect, which persists with the new representations that enter.

Let us take the most simple case. Originally the idea of time finds a condition indispensable to its genesis in the succession of sense impressions. Let us suppose a consciousness free from all other representations; and receiving only regular acoustic impressions, for example, the swinging of a pendulum at regular intervals. The first beat has its place in consciousness; its image persists until the second follows. This reproduces the first immediately. By virtue of a general law of association, identical or analogous states of consciousness excite each other. But at the same time the second beat encounters the image that has persisted during the interval. The new beat and the image are referred to the first perception, and to it the repeated impression gives its original intensity, while the image remains in a state of memory. Consequently, the present perception is immediately distinguished from its image. We have in this simple fact all the elements of the idea of time: the first sound is the beginning; the second, the end; the image, the interval of time. At the instant of the third impression, the notion of time exists entire, all at once, since the three elements are given simultaneously: the second impression and the image immediately, the first impression by reproduction. But we are conscious at the same time, of a state in which the first impression existed alone, and of another in which the image existed alone. This state of consciousness constitutes the notion of time.

The question has been put under its simplest form. But more complicated cases suppose the same fundamental psychological process. Thus the last point may be different from the initial point; there may be, between the two points, not a pause but a series of other impressions, etc. In these cases one of two things happens, at the moment that the final impression is made: either it is analogous to the initial impression, when the process is as above, and we have a determinate idea of the lapse of time; or there is no occasion for a reproduction, when we have an *indeterminate* idea of the lapse of time.

Space.—We have already spoken of the genesis of the concept of space. We have seen that its characteristics are, *plurality*, *continuity*, and *homogeneity* of dimensions; that the idea of space arises from a synthesis by which the heterogeneous continuity of two dimensions formed by local signs, is referred to a homogeneous continuity by means of sensations of innervation, which are continuous, but of one intensive dimension only. We have seen also, that, by virtue of the laws of movement, the right line serves as elementary measure of space, and that, from these diverse conditions, the concept of plane space of three dimensions is formed.

The pure intuition of space is a concept which always assumes the form of *particular* representation, *i. e.*, of an object in space; and as the existence of an object in space supposes other extended objects besides itself, it results that space as a concept, like time, is unlimited.

Wundt's considerations on the concept of space, afford, according to the hypothesis of imaginary geometry, ground for considering ordinary geometry a particular case of a much more general science. "Investigations in imaginary geometry, from the side of mathematics, conduct to results analogous to those reached by our physiological analysis. These investigations show that space, considered as a continuous diversity of homogeneous dimensions, is a general concept of which our intuition of space is a particular form. On the other hand, physiological analysis shows that the particular form of plane space of three dimensions has its ground in the determined conditions of our organism. But mathematical considerations can not lead us farther. We cannot conjecture, as Zœllner has in his book *On the Nature of Comets*, that the ultimate world-space is of varying curvature. For, whatever view we hold as to the relation of our representations to the real world, we can never justify the assertion that real things should be represented in a form in which we are not *able*, in a general way, to represent them. Scientific theories of the nature of matter may put very various constructions upon the appearances given us in immediate perception; but they can never establish hypotheses which do not conform to our general intuition of space and time. The representable can never be derived from the irrepresentable. The imaginary forms of space have a real value in a certain sense, in as far as space is the form in which we represent diverse continuities; but we have seen that there are continuities (for example, color) which can not be construed in ordinary space."

As to whether space is merely a subjective form of thought, or has also an objective reality, this question does not belong to psychology. As an empirical science, psychology asks how we can perceive things under this form, but nothing farther.

V.

UNITY OF COMPOSITION: APPERCEPTION.

In his early works, and even in the first edition of his *Physiologische Psychologie* (p. 714), Wundt took a position that is worth recalling. It may be stated thus: at the base of all psychic phenomena, there is unity of composition; all are reducible ultimately to *conclusions*.

Thought—understanding by this word a state of consciousness in general—can be considered as to its form and as to its nature.

In form, thought sustains the condition of time. Every act of thought has measurable duration: we are not able, moreover, to have two states of consciousness at once. Internal observation presents a false appearance of simultaneousness, the error arising from rapid succession. It is one of the numberless cases in which observation alone deceives us, and ordinary facts readily explain the illusion. When the smith strikes red hot iron with his hammer, we see the spark fly before we hear the blow. When the physician bleeds a patient, he often sees the blood flow before the lancet has penetrated the skin. These facts, as well as scientific inquiry into the duration of psychic acts, show that we can not think two things at once. They show further that in this rapid succession which we take for simultaneousness, the second phenomenon may be perceived before the first, for it is evident that the stroke of the hammer precedes the spark, and the slip of the lancet, the drawing of blood. These facts, and others like them, have, says Wundt, a psychological significance; they are the expression of an internal fact, *the oneness of thought.*

In its ultimate nature, fundamentally, thought may be reduced to a single fact: reasoning, inference (*Schliessen*).

There is, in all mental phenomena, however varied and diverse they may be, oneness of composition. Sensations of every kind, judgments, ideas, feelings, etc., are reached by reasoning, are the results of inference. All differences arise from different degrees of complexity only in the original act, and from the diversity of the materials that enter into it; so that the mind, thus interpreted, may be defined as a thing that reasons.

This is Wundt's fundamental position. However obscure and unexpected it may be, we beg the reader to accept so much on trust; only after he has read the author, can he accept or reject it, with proper knowledge of the case. Yet, to simplify his task, we will try to indicate in some detail the course that Wundt pursues.

All psychological data are referable ultimately to a single fact: sensation. The most simple sensation is to Wundt a conclusion. What does a conclusion suppose? Premises. What are the premises here? Facts absolutely unconscious, of physiology and the nerve processes. There is, then, this difference between ordinary reasoning and simple sensation: in the former, both premises and conclusion are conscious acts; in the latter, the premises are physiological states, and the conclusion alone a state of consciousness. It is generally said, to think is to judge. Wundt maintains, on the contrary, that the act of judging is not original; that as a conscious state, it presupposes a series of unconscious states; it is a term of the operation, not the whole; this latter, the reasoning process, is a synthesis of premises.

Wundt applies the same method to all the forms of psychic activity. Each higher form is a conclusion for which lower forms are premises. So that, complex phenomena being referred by analysis to phenomena more and more simple, these to sensation, and sensation to the nerve processes, we are led to seek the hidden law of all psychological phenomena in the unconscious, that is, in the domain of physiology.

This throws light upon the analyses that follow.

"In order to understand well the connection of the internal laws of thought with their external manifestations, we must have their essential elements well before us. Now the elements of thought are ideas, judgments, conclusions. Ideas and judgments form a stable domain, embracing science and all knowledge. Conclusions are the means by which we give value to this domain, and without which all our ideas and judgments would remain unproductive capital. We will see that conclusions are essential to thought, considering the manner in which judgments and ideas are formed."

It is indisputable that the formation of any judgment whatever—the lion is an animal—presupposes a great number of antecedent mental acts. Not to enter into an analysis that would be very long, and which the reader, upon reflection, will supply, we will offer only a few remarks. I can know that this object is an animal only after I have compared it with a great number of other objects, similar or different (plants, stones, liquids). Each object is characterized by a certain number of *marks* or qualities peculiar to itself; and the comparison of two or more objects can take place only when the marks of the objects compared are in part similar, in part different. A judgment is the result of such a comparison of different things by means of their characteristic marks.

Every judgment of this kind, founded upon a considerable sum of experiences, arises, then, from a great number of antecedent judgments, of which some are affirmative, others negative: for we determine a thing by saying at once what it is and what it is not. And each of the experiences that serve as basis for the entire judgment, is itself a judgment, since, when I wish to express an experience, I must give expression to a judgment. But these judgments passed on given objects, have no bond of connection among themselves. In order that they may conduct me to a final judgment which shall comprehend my entire intuition of the object, it is necessary that some bond unite these scattered marks. How is this connection made? Do my experiences remain a scattered aggregate? Or is there something which unites them profoundly? We know only a single form in which judgments can be bound together; it is the *reasoning process*.[1] The conclusion unites a certain number of given judgments in a new judgment.

What is the nature of this reasoning process? It is an induction, for it proceeds from the particular to the general. Wundt is here in full accord with Stuart Mill. He remarks that all deduction supposes a previous induction, since the principle that serves as basis for the deduction must be the result and condensation of a mass of antecedent experiences.[2]

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[1] *Raisonnement*—translated sometimes also *conclusion*: the two ideas are included in the corresponding German word *Schliessen*.—Tr.

[2] *Menschen u. Thierseele*, I, lect. 4. Wundt remarks that inductive as deductive reasoning rests upon three points: 1st, judgments or affirmative facts (such and such a man is dead); 2d, judgments or negative facts (there is no example of a man who dies not): without these latter, the affirmative facts, however great their number. are valueless; 3d, the general conclusion, serving, in its turn, as basis for deduction.

These judgments of experience,—which are, at the same time, particular, and from which we draw the laws of nature and of thought—seem to be the original elements of our knowledge. Yet it is possible to pursue the analysis further and show that they are composed of yet simpler elements. In fact, there is no judgment, however simple it be, which does not suppose some previous act of thought. But if I resolve a judgment into simpler forms and these into yet simpler, what result do I finally reach? Primitive sensation. Every object is given me as having such a color, form, as undergoing such changes, &c., &c. In short, the ultimate *marks*, those at which we are obliged to stop, are everywhere and always perceptions of sense.

"But every perception of sense is itself a judgment of experience, the simplest of all such judgments. What I see is white, red, brilliant, corporeal; these are judgments of experience, data of sensible intuition. Are these primitive acts of thought or do they suppose others?

"When I am conscious that what I see is red, I thereby distinguish it from yellow, green, blue, &c. I distinguish likewise a sensation of light from a sensation of sound or touch. How do I make this distinction? Evidently by means of definite marks that the object possesses in my sensation. These marks agree in part, differ in part. Thus objects that are red, yellow, green, &c., agree in certain marks and differ in others, as sound, smell, &c. But we have seen that each of these marks is nothing more or less than a judgment. Every perception of sense, then, results from a mass of judgments, partly affirmative, partly negative, and the perception itself is nothing else than a conclusion drawn from these judgments.

"This leads us farther. The original act of thought is not the judgment that exists in the immediate intuition of sense, but the judgment that expresses the especial mark of the sensation. How is this really primitive judgment formed? It has a property absolutely peculiar to itself and it can not be expressed. Neither words nor thought can grasp it. We know nothing of it, except that it exists. I know, indeed, that the sensation red is distinguished by marks from that of blue, green, &c. What are these marks? This is absolutely unknown. We can not discover these marks either by the most profound reflection, or by the most minute research into the conditions under which the sensation is produced. We know, indeed, that ether undulations of a given amplitude, falling upon the eye, produce the sensation of red. But these undulations are not the marks by which we distinguish red from other colors, since we made this distinction long before we knew that light resulted from undulations of ether."

These primitive judgments present, therefore, such a character, that their existence can not be doubted, and yet that their content, their fundamental constitution, remains entirely unconscious. "Conclusion, not judgment, is the beginning of thought." A judgment, as a state of consciousness, exists only in consequence of a process of reasoning. So that we may say "the conclusion is knowledge that *becomes* (*qui se fait*), the judgment is knowledge that *is reached*" (*qui est faite*).

It remains to account for the third form of thought: the *idea*. It results also from the reasoning process. If I take, for example, the idea man, I observe that it presupposes a number of experimental data, each of which is characterized by a mark: he is of such a form, he moves, he thinks, &c., &c. These are the judgments that make up my idea man. But the idea does not result from the simple juxtaposition of these judgments; for if this were the case, the idea would be simply a sum of marks, and a sum of marks no more constitute an idea than head and limbs upon a trunk constitute a man. The idea arises from the fusion of all the marks into unity. And whence comes this fusion? Evidently from the one form of mental activity by which we have power to bind, to unify, i. e., the reasoning process.

It has been remarked that, in this reduction of all the forms of mental activity to one, Wundt is not in accord with the common doctrine; and he has himself observed it. "We have shown that the true series of psychic acts is altogether different from that generally supposed. We do not admit first ideas and from these judgments and then conclusions; but thought commences with conclusions, and they conduct to judgments, which in turn give ideas." The activity of thought consists in the reasoning process alone; all the rest is a result, a product. So he establishes the *unity of composition* of thought. All mental activities and faculties are finally reduced to a single form, and this form is essentially a *succession*. All mental phenomena are referred to a *logical* operation (the reasoning process).

These are the general characteristics of the fundamental position of the author. In the second edition of his *Psychologie* he places the unity elsewhere, in a psychological state called by a term borrowed from the philosophy of Leibnitz: *apperception*.[1]

In the come and go of internal states, we are more or less clearly conscious of an activity which we call attention. Internal observation teaches us that this activity does not attach equally and at once to all states of consciousness, but that it is sometimes exerted in a high degree. Consciousness has been called internal vision. Adopting this figure, we may say that all the representations of consciousness at a given moment are in the visual *field* of consciousness, and those to which the attention is directed are at the visual *point*. "The entrance of a representation in the visual field, is perception; its appearance at the visual point, is apperception."

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[1] *Grundzüge*: I, p. 218; II, p. 305, &c., 384, 392, &c. M. Wundt writes to us on this subject that he does not now consider the hypothesis of unconscious reasoning as more than a general expression, for which, in actual states of knowledge, the processes of association and apperception must be substituted. Every psychical process may take a logical form; but this form is not the process itself; it is a popular way of expressing clearly that it is psychic processes which are emphasized in this case. For a complete study of apperception, see an article by M. H. Lachelier, "Psychological Laws in the School of Wundt." (*Revue philosophique*: Feb., 1885.)

Apperception is passive or active. Passive precedes active apperception. Apperception which by necessity attaches to a strong representation is passive. Active apperception arises when several impressions enter into conflict. It is, then, in general, an activity opposing certain states of consciousness, sometimes passively determined by a controlling excitation, sometimes appearing as active choice among different impressions. Its function in both cases is to reinforce the central excitation. The boundary between the two cases is indeterminate. The preponderance of a single excitation suffices to give passive form to the apperception; the presence of another excitation of the same intensity gives it active form.

We must believe, moreover, still denominating apperception the visual point of consciousness, that we here arrive at a principle of unity in the order of knowledge, as also in the order of action. Apperception is the primitive form of will. We will study it later (§ X) under this new aspect.

Wundt applies this theory of apperception to an anatomo-physiological hypothesis, indicated briefly as follows. He thinks that the frontal regions of the brain are concerned in the physiological phenomena which accompany the apperception of sense representations. As long as the central excitations remain limited to the sense centres, properly so called, we have simple perception; but their apperception is always connected with a simultaneous excitation of the elements of the central region. Each act of apperception is accompanied by a determined physiological process: one of the clearest examples is the sensation of effort that accompanies intense apperception. With this sensation, probably central, muscular tension is often combined, to be referred necessarily to a simultaneous motor excitation. Let us suppose the organ of apperception to be joined to a double system of conducting ways: one *centripetal*, transmitting centrally sensor excitations from all the organs of the body; and the other *centrifugal*, transmitting impulses issuing from the frontal region to the sensor and motor centres. According as impulses are transmitted to the sensor or to the muscular centres, the result is the apperception of sensation or the execution of voluntary movement. Very often the two operations take place together: we perceive a representation and execute, at the same time, an external act that corresponds to it. The conducting ways which proceed from the organ of apperception are connected in each of two principal directions—centrifugal sensor and centrifugal motor—directly with the sensor and motor centres, and indirectly also, by means of intermediate centres, that represent,[1] in certain complex functions (articulation in speech, writing, &c.), nodal points of transmission.

It remains to speak of the role of apperception in the association of simple and composite states of consciousness. This point will be treated in the next chapter, in connection with the discussion of the duration of psychic acts.

VI.

FEELING.

To consider the feelings, we must revert for a moment to sensation, and examine its third characteristic, spoken of above, and postponed until now. As we have seen, it is only in abstraction that a sensation has two characteristics—intensity and quality; in reality, every sensation is conscious to a living being and has consequently a tone.

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[1] *Grundzüge*, I, 218.

The feeling or tone of sensation is either agreeable or disagreeable. Pleasure and pain are contrary states, either of which is transformed into the other when a point of indifference is traversed. There are sensations at this point which have no *tone*, are accompanied by no feeling. Since the relation of sensation to consciousness is continually varying, this point of indifference answers in general to an easy state of transition to pleasure or pain. Yet there are many sensations whose accompanying feeling is so feeble that they seem to play always about the point of indifference. With others, the feeling is so strong that it hides the sensation. The former are sensations properly so called.

Since feeling is a relation to consciousness, that is, a continual change of state, it is open to exact analysis in a much less degree than the other elements of sensation. In a good historical *résumé* Wundt reduces the hypotheses hitherto advanced on the nature of feeling to three.

According to the first, held by the most noted thinkers, from Aristotle to Kant, feeling is an immediate affection of "the soul," caused by sensation. All the doctrines of this group find, more or less, in feeling an element of knowledge. But experience tells us nothing of pleasure or pain of "the soul;" it gives us knowledge of states of consciousness only; we perceive our feelings as immediate affections of consciousness, and there is no reason for substituting the metaphysical concept soul for the empirical concept consciousness.

According to the second, represented by Herbart and his school, feeling results from a *reciprocal relation* between sensations or ideas: it is not a primitive state. Reciprocal antagonism of sensations gives rise to the feeling of pain; their reciprocal union to the feeling of pleasure. This theory involves a great difficulty: it does not explain the simplest form of feeling, that which accompanies sensation; for, in this case, there can be no question of reciprocal relation between ideas. It is applicable only to the more complex feelings, notably those of the æsthetic order.

According to the third, held by the author, feeling is the subjective complement of sensation and the result of an internal activity: apperception. We will approach nearer the truth if we conceive the relation in this way: in the indissoluble whole which we call a sensation involving quality, energy, and some shade of feeling, the shade of feeling is the element that sustains no direct correspondence with the objective conditions of the excitation.

If we give this last expression to the relation sustained by the tone of feeling to the other elements of sensation, the thought is suggested that we ought to find in the tone an intimation of a process *more central* than that which pertains to the quality and energy of the sense excitation. In fact, sensation, however simple a process it may seem, is complex both from the physical and from the psychical side. And since we are absolutely incapable of saying anything touching sensations that are not perceived, the act of apperception constitutes an element inseparably connected with all the sensations offered for psychological examination. Thus feelings of sense become immediately intelligible, under all the influences to which they may be subjected, if we consider them as *modes of reaction, exerted through the activity of apperception, against sense excitation.*

This supposition explains at once, in the most simple way, the multiplied psychological conditions of the tone of sensation. Apperception depends, on one side, upon excitation experienced, on the other, upon the state of consciousness as a whole, in such a way that it is determined by the combined action of present impressions and past memories. Apperception is an internal activity, and thus the subjective value we attach to the tone of each feeling is explained. Finally, this internal activity must be absolutely the same as the efficiency of the *will;* and this explains the fact that the direct perception of feeling inclines us to attribute to it some relation to the will. In order to write and explain more clearly what we feel within, in pain or pleasure, it is better to call pleasure an aspiration or tendency toward an object and pain a disinclination or repulsion from it. In our descriptions we continually confuse feeling, instinct, determination of the will, because all these states are really connected, and are separate only in our psychological abstraction, and because apperception exhibits in the play of external impressions, sometimes a passive and sometimes a spontaneous activity: in the first case we speak especially of feeling, in the second, of instinct, desire, and will.

At the same time, the property, common to the feelings and all analogous states, of moving between contraries, indicates immediately their relation to the will. When the will is full-grown, developed, this opposition finds expression in the fact that some sensations are voluntary and others involuntary. Now the excitations called pleasure and pain which oppose the activity of apperception, are necessarily anterior to this opposition between the voluntary and the involuntary.

The psychological relation of the feeling in sensation to the process of apperception must determine our conception of the fundamental physical basis of this process. The intensity and quality of sensation depend directly upon the processes of excitation produced in the sense centres, and, further, since they are measured in terms of their reciprocal influence, upon the activity of apperception, which finds expression in the law of relation. But the tone of feeling is present only in as far as the sensation is perceived. It must be considered then directly as the subjective or psychic side of the more central process which is connected with the central sensorial excitation, when the activity of consciousness is turned toward this point. The variable energy of this reaction of feeling is to be referred, from a physiological point of view, to the mobile states of the organ of apperception, states that are analogous, in some measure, to the changing states of reflex excitability in the inferior central organs.

These comparisons show the psychologist as well as the physiologist that the general law of relation which governs the perception of the intensity and quality of sensations is equally valid for the reaction of feeling. This law was formulated for feeling before it was applied to the other elements of sensation. Daniel Bernoulli, to whom we owe its application to the complex feelings, called it the "*mensura sortis*," and Laplace, interpreting it in the same sense, gave it the form of a law of relation between the "*fortune physique*" and the "*fortune morale*." In its general significance the law is formulated thus: *The intensity of the reaction of feeling increases proportionally to relative increments of excitation.*[1]

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[1] In Wundt's early studies on sensibility, there was a marked tendency to refer it in large measure to the intelligence. "In every feeling, every affection, and every inclination, there is, says he, an instinctive cognition. The feeling, indeed, is identical with the cognition and disappears when the latter becomes conscious. When we say that feeling is an instinctive cognition, we mean that it rests unconsciously upon the processes that constitute cognition in consciousness. So it enters in consciousness only as a result. We can never resolve it into elements as we can known truth. And the cognition may be mistaken only in so far as there is not a clear consciousness of the logical operations from which it flows: but feeling is always uncertain, since we can never know clearly the method of its production. Feeling can never attain truth; it can only point it out; it shows the way and is the pioneer to knowledge." *Menschen u. Thierseele*, II, pp. 41–44, also p. 31. All knowledge is originally instinctive. Wundt gives examples: the penetrating glance of the naturalist and physician; the experimental method instinctively used by the alchemists before Galileo, &c. (lect. 43).

VII.

After having treated of the feelings whose basis is purely physical—those which depend upon the state of organ and tissue (*sinnliches Gefühl*)—the author studies three important groups; the æsthetic, the moral, and the religious feelings.

We have seen that, in the order of intellect, the entire process of thought consists in the transition from perception to *ideas* or abstract notions, which constitute the limit of knowledge. In the order of feeling, the process is analogous. It is a transition from purely physical affections to an *ideal*, which sets limits to the play of the three groups of feelings of which we speak. The relation of perception to the idea is analogous to the relation of feeling to the ideal, except that the former is conscious, the latter, unconscious. "Ideal, then, is a word which defines the limit of the unconscious process of knowledge, as idea that of the conscious process." As the idea results from a sum of marks and from logical operations which are entirely conscious, we can always refer it by analysis to the concrete elements that produced it. The ideal, on the contrary, does not result from clear operations, and can not be resolved into a given sum of predicates: hence it has an indeterminate character, and we denominate it "infinite." The task of the sciences, adds Wundt, is to transform all ideals into ideas.

His theory of the ideal, as we see, is not at all mystical, and the same may be said of his æsthetic as a whole. It rests upon geometry and physics. Evidently only a rough sketch of æsthetic is possible in the present state of the science. Yet, when we read the *Optics* and *Acoustics* of Helmholtz, the memoirs of Fechner on *experimental æsthetics*, the works of Zeising and Brücke, we see the possibility of replacing vague discussion and uncertain generalization by a theory resting upon the positive sciences, the possibility of an æsthetic which will differ widely from our present science of the beautiful. We will attempt, following Wundt, to indicate some of its features.[1]

In æsthetics two methods are generally pursued: one, the speculative, sets out with the idea of the beautiful and deduces its laws; the other, the empirical, sets out with the analysis of beautiful objects and works of art, and reaches æsthetic laws by induction. Hegel represents the former, Lessing the latter. The advantages of both are united in the *experimental method*, which seeks, says Wundt, to determine the factors and thus the simple elements in any æsthetic effect.

Let us take impressions of sight. Here there are two factors, the form and color of objects seen. The analyses of physicists, Helmholtz in particular, have shown that optics afford a solid basis for an æsthetic of color. We will consider the former of these elements. Of two very simple figures, a square and trapezium, one of which is regular, the other irregular, the former pleases, while the latter does not. Why? Because the former offers greater *symmetry*. If we compare a great number of forms, in architecture, sculpture, painting, and even in living organisms, we see that the *law of symmetry* is a fundamental æsthetic fact. Not that naked and bodiless symmetry is pleasing; on the contrary, the effect results from the proper ordering of a plurality of elements.

Geometricians discovered, long since, a linear division which is valuable in æsthetics. To put the question under its simplest form, we are led to ask: if two straight lines cut each other at right angles, what is the most pleasing relation between the vertical and horizontal sections. If this relation is 1 : 1, there is perfect symmetry. But there are other proportions which please: the relation 1 : 1.6. What is the mysterious law that these numbers express? On an examination of the figure, we discover it immediately. Our two lines form a cross, whose vertical section = 1, and horizontal section = 1.6. By addition, 1 + 1.6 = 2.6, the entire line, and we then have the proportion 1 : 1.6 :: 1.6 : 2.6 (or, to be exact, 2.56). In other words, we have this law: *The finest effect in vertical proportion is produced when the smaller section is to the greater as the greater to the whole.*[1] Zeising, in his *New Theory of the Proportions of the Human Body*,[2] was the first to verify this law in its application to the masterpieces of ancient architecture, the Parthenon, Erechtheum, Propylæa, and even, in a measure, to Gothic art; to the most beautiful models of Greek sculpture; to the human body as it exists; and further, throughout the entire animal and vegetable kingdoms.

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[1] *Menschen u. Thierseele*, II, lects. 33–36, and *Grundzüge*, part 3, ch. 14.

This suffices to indicate Wundt's conception of æsthetics. In the order of auditory sensation, he studies similarly the three factors, rhythm, melody, and harmony; and deduces their mathematical conditions. Thus two sounds are harmonious if their vibrations sustain a simple numerical relation, as the octave 1 : 2, the fifth 2 : 3, the fourth 3 : 4, etc.

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[1] All æsthetic proportions in form range between perfect symmetry 1 : 1 and the relation 1 : $\frac{1}{x}$, where x is so great that $\frac{1}{x}$ becomes very small in relation to 1. A proportion which scarcely departs from symmetry is less pleasing than one further removed, because it appears as an unfinished symmetry, lacking completeness. On the other hand, when the smaller dimension cannot be measured in perception relatively to the larger, the effect is very disagreeable. Between these limits the æsthetic proportions are found, according to the law given above (x + 1 : x :: x : 1). *Grundzüge*, II, p. 183. We have spoken particularly of the work of Zeising, because he is less known than Fechner and Helmholtz: Wundt has shown at length the importance of Helmholtz's work in the æsthetic of music.

[2] *Neue Lehre von der Proportionen des menschlichen Körpers*, Leipzig, 1854.—Tr.

It is impossible to pursue the details here. The important point is the method; it is briefly this. We make a physiological and physical analysis of sensations which produce an æsthetic effect, fix this analysis with numbers, and thus derive a law. Wundt remarks that "the analysis of æsthetic feeling conducts everywhere and always to the same process: a process that begins with the *comparison* and *measurement* of impressions. The æsthetic feeling is satisfied when this comparison shows harmony among impressions; and in the highest degree when this harmony arises from a diversity of elements."

Since it is the function of science to transform every *ideal* into an abstract *idea*, to what idea does the beautiful correspond? To that of *order*. Every æsthetic phenomenon expresses this idea, that the world is not a confused mass of units with no bond of union, but a *cosmos*. And herein the beautiful approaches religious and moral ideals. The eternal order of nature seems to us incomprehensible and infinite, and it is in this idea that religion has its root. *External* order indicates an internal order that is bound to the order and development of the universe as a whole: this gives rise to moral sentiment.

Existing at once in nature and in mind, in external forms and in thought, "the beautiful speaks to us of the profound agreement of the laws of the external with the laws of the internal: the two are one in nature, and our intuition alone makes and keeps them separate."

VIII.

All the feelings, and not those we call *moral* alone, may determine us to action: the practical importance of the moral feelings, however, is very great. Yet the moral is as indeterminate as the æsthetic. The good and bad serve as basis for an *ideal* only, the result of an instinctive cognition. The moral ideal, like the æsthetic, is a vague and imperfect notion which scientific analysis must reduce to clear *ideas.* Morality as a science, has as great a task as æsthetics. Unhappily, the good, as an idea, has not been resolved as yet: and as an ideal, its origin rests enshrouded in the shadows of the unconscious. Kant, it is well known, placed the origin of this feeling outside the range of psychological research: the moral law was for him altogether special in its nature, having nothing in common with the general laws of knowledge, indeed, opposing and hindering them. But to show that this position can not be maintained, it is only necessary to remark that the moral condition of man is most intimately connected with the development of knowledge. Although this relation can not be questioned, we know the moral ideal only as a vague form of feeling. What is necessary to make it clear?

If the individual appeal to consciousness only, he makes but little progress, for this is a question of origin. The real concern is to know by what unconscious induction this full-grown consciousness was formed within him, from which in each case he deduces the motives of his action.

If we study the history of ethical theories from the dawn of philosophy until to-day, our failure is as signal; for we find in all these theories different forms of individual reflection only. Here the results are clearer, however, inasmuch as they are expressed by loftier minds; but the question of origin remains untouched.

In order to study the feeling of harmony, we must know objectively what harmony is. In like manner, in order to understand moral sentiment, we must know objectively what the *moral* is. We can learn this from history, especially from the natural history of man, which carries us back to ages that are prehistoric, to the origin, in primitive custom and rude organization, of the moral sentiments which we find ready at hand in consciousness. Anthropology, therefore, ethnology, history prehistoric—these must serve as guides.

Wundt devotes several chapters of great interest to noting and interpreting ethnological facts of all kinds.[1] We will indicate the principal points.

The moral life of a people is expressed in their *customs*; from the state of their customs we can infer the state of their morals. Now, as the lowest society has its manner of life, *i. e.*, its customs, to study these is to study indirectly the feelings which produce them. It may be said further that, at the most primitive state, a people has only custom. It is only as its historic life begins that it attains unto law,—law that generally embraces, rules, and provides for all things. Then the circle of law is contracted, legislative and statute morality is reduced to a minimum, and individual life is ruled by custom. England is a striking example.

Custom, then, is the whole of primitive morality. But in custom there is no contract either explicit or implicit. It is an instinctive feeling which the individual blindly obeys. Among peoples in a state of nature, it is determined in large part by climate and surroundings. In general we may say that extremes of temperature are not favorable to moral culture. Yet here there are exceptions. In the arctic zone, while the Kamtchatkans and the inhabitants of the Aleutians are lawless, the Greenlanders have a certain moral tone. And in the tropics, we find, in the same latitude, the Bushmen, Hottentots, and Australians on the one hand; and on the other the ancient civilizations of Mexico and Peru.

Among primitive peoples, one of the most embarrassing customs to the moralist is cannibalism, a phenomenon probably universal to the human race in a state of nature;

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[1] *Menschen u. Thierseele*, II, lects. 37 and 41.

for the accounts of Marco Polo lead us to think that it existed as late as the thirteenth century in China and Japan. Wundt suggests its probable causes—the entire destruction of an enemy, scarcity of food, the delicacy of human flesh, considered so great by the inhabitants of the South Sea islands, that the privilege is reserved for the great. He shows, however, that even among primitive peoples, cannibalism was indulged under protest. In the Fiji Islands, before the arrival of Europeans, factions combatted as "immoral" the "good old custom" of eating men.

The author next studies, with the customs that characterize them, the three forms of social organization which precede civilization, properly so called: 1st, the life of *chase*, with its mixture of barbarities and virtues: the heroism of the prisoner of war among the North American Indians, regard for promises, hospitality, etc.; 2d, the *nomadic* life, of which the Mongols offer a type: united once by the genius of Tchengis-Khan, they wander on the plateaux of upper Asia, with no memory of their ancient splendor; 3d, the *agricultural* life, which, in its sedentary character, lays the first steps toward civilization. The Foullahs and Mandingos, negro tribes of the interior of Africa, offer examples of the transition from the primitive to civilized forms of life.

Does the family exist in a state of nature? We can not reply to this question categorically. Inasmuch as it is generally maintained that the social bond becomes stronger and more constituent as culture advances, we are led to conclude that there was a primitive state in which the individual was absolutely isolated. But this is a conclusion *a priori*. Since the true state of nature is nowhere to be found, we are compelled, if we would reason from facts, to resort to the study of animals. Now we find that many of the higher species have a sort of marriage, and live in a state of polygamy or even of monogamy. Analogy would lead us to believe that, with primitive man, the case was the same. The oceanic races, negroes, the peoples of the icy zones, and the primitive tribes of America, offer different and curious types of domestic life.

The author then shows how the state arises from the family; whether it be the patriarchal form, of which China still offers a curious model; or the despotic, which often arises, as with the negroes, from the necessity of resisting an enemy. To these primitive forms succeeds the rule of caste (India, Egypt, Persia), vestiges of which are still found in Greece and Rome. Finally historic life appears, with democracy, centralization, etc., etc.

"The varied changes which ethical notions have undergone in the course of history, however incompatible with each other they may seem upon objective observation, have nevertheless a subjective bond of union. The moral end that notions strive to attain remains always fundamentally the same; it is the means alone which change. There is an identity of character that reappears in all the variations in morals. *The conscience of nations, as well as of individuals, designates as moral every act that is useful to the agent himself or to others, to the end that all may live conformably to their own nature and in the exercise of their powers.* Thus, at first, one factor is supreme, physical force; it is only a question of physical needs. Then little by little knowledge opens up a new way. Society appears as a whole whose members are united together, and the notion is developed of duty to others and to the state."

Such is the result of the study of the ethnological facts which we have briefly indicated. Its concern is to interrogate the national consciousness with a view to the transformation into clear ideas of the vague feelings within us. The historical development of moral notions reveals especially a process of knowledge, from an unconscious original; for it is only by knowledge, by a reasoning process based upon experience, that the individual sees the necessity of submitting, in common with others, for the development of his faculties, to the rule of custom and law. This unconscious reasoning, the basis of moral feeling, is enriched with conscious elements, and approaches constantly nearer its ideal end. Hence it comes that every epoch, while believing its moral law perfect, expects a law still more perfect, and this expectation has never been disappointed.

IX.

The religious feeling affords a study of great interest: and it has a character of novelty, for Wundt is one of a very small number of psychologists who have attempted it. Whether it be from mistaken respect, or prudence, or disdain, it is generally entirely overlooked. The problem of the origin and nature of religious sentiment, in whatever way we interpret it, still arises for recognition; and the role that this sentiment plays is too important to be neglected. The method to be pursued here has been indicated elsewhere; we must begin with the facts of ethnology and history. Not that we are concerned with the history of religions; that is quite another thing. But it is needful by the study of facts, that is, the facts of all forms of religion, rude and refined, to build up our psychological interpretation, and so discover the different processes from which these varied forms have arisen.

The task is fraught with insurmountable difficulties, and if we consider merely the hot strife of opinions in the domain of religion, it becomes evident that this feeling can not be transformed into clear ideas. Further, the creative imagination plays so great a part in religious conceptions, that it may well be asked if they are not as much the work of fancy as of feeling.

Yet these facts seem to prove that all religion is, origially, the worship of the forces of nature. This is their common point of departure, and their salient point of difference. Differences arise from the character of peoples, the influence of external nature, the creative work of poets, the reflective work of philosophers, and these influences often unite in hopeless confusion.

All the forms of worship of Asia, China perhaps excepted, are addressed to the changeless phenomena of the starry heavens. Chaldea gives us sun-worship in its purity. Peru is an analogous case in the New World. But it is worthy of remark, as showing the influence of nature upon religious conceptions, that the Chaldee religion, while passing from the open skies and uniform country of the Euphrates into Phœnicia and the fertile region of Syria, shut in by rivers and irregularities of territory, takes on a *terrestrial* character. Babylonish Mylitta becomes the goddess of fertility for man and beast. Astarte, the opposing divinity, presides in war. Thus birth and death are no longer ascribed to the influence of the sun. The marked contrast in the seasons in Syria and Phœnicia gives rise, in the same way, to a multiplication of many gods from the original few. Egypt, as far as we can conjecture, had at first a worship like that of Chaldea, but the influence of nature is seen also here. The refreshing overflow of the Nile is followed by seventy-two days of devouring heat; this natural event becomes a myth—Osiris beaten to death by Typhon and his seventy-two companions. In India and Persia there are myths of the same kind. The Vedas tell of the combat of Indra the sun-god with gloomy Mist; and in the old hymns of the Zend-Avesta, the Spirit of Light strives with Demons of darkness.

In this worship of the forms of nature, a tendency is developed more and more to *personify* the gods. This tendency, very perceptible in Eastern religions, attained its highest state in Hellenism.

From the results reached, we may generalize this conclusion: the worship of the forces of nature takes on one of two forms. It is addressed sometimes to regular and calm phenomena (Chaldees, Egyptians), sometimes to changing, violent, destructive phenomena (Jews and Indo-Europeans). It tends in almost all cases to the personification of these forces.

Let us now attempt to interpret the psychic process from which religion and cultus spring. Here, as everywhere in the domain of feeling, we have a case of instinctive cognition. The mind receives from experience certain data and elaborates them unconsciously by laws peculiar to itself; and the result merges into consciousness. How does the mind arrive at this result? In other words, what is the intellectual process at the basis of religious sentiment? It is a *process of reasoning in analogy*. Science tends to refer all its matter to the category of clear ideas: it is gaining ground constantly. But there is always a residuum called by Wundt and others the unknowable. Science can penetrate it neither by induction nor by deduction. What, then, is our recourse? Analogies may be found in all things and everywhere; and so analogy, although the most vague and imperfect of all the logical processes, remains when no other mode of reasoning is possible. Man in a state of nature sees everywhere wills analogous to his own, in the thunder, in the stars, &c., and thus he forms the conception of gods like to himself, and differing from him only in the possession of superior power.

But this is not all. When the gods have thus taken on living form, they detach themselves from the phenomena in which they were first perceived. They become living beings with a high hand upon human destiny. This leads to another form of the religious idea: the nature-god becomes the fate-god.

One of the grossest forms of this religious conception is fetichism. It has two distinguishing characteristics: 1st, the idol is itself god—a stone, a tree, a broken urn, a piece of pottery, as among the Bambarras, according to Mungo-Park; 2d, each individual has his god to adore, maltreat, or burn as the circumstances may require. The fetich is for the individual at first, although it may extend its power over a family or tribe. Thus among the African tribes, when some disaster befalls, the warriors go forth in war to conquer the hostile fetich, bring it back in triumph, and worship it. The fetich is a fate-god; herein is the profoundly egoistic character of this form of worship.

It is generally understood that fetichism is peculiar to the lower races. But there are incontrovertible facts which go to show that it is psychologically possible among cultivated peoples. Not to speak of faith in talismans and amulets, "we find that among the Greeks, the Zeus of Olympus was not the Zeus of Crete, &c. With Christians, the saints have special miraculous powers in different chapels. The Virgin Mary has hundreds of names according as the pilgrim bows at one shrine or another: and further, each cross, each holy image, upon his way, has its own peculiar worship."[1]

Next to fetichism there is the worship of animals as it existed in ancient Egypt, and is still found among the negroes of Africa, who worship the serpent, the hyena, the crocodile, the tiger, the elephant. What is the genesis of this religious form?

Wundt answers the question as follows. To man in his natural state everything astonishing is divine and everything that exists is astonishing. Not the lightning and thunder alone, but the river that overflows, the leaves that tremble, the brook that murmurs, all are supernatural to him. The negro in particular is inclined to attribute to animals intelligence superior to man's. The negroes of Borneo speak of a time when "man understood the language of the beasts." And the instinct of animals, so mysterious to us, is still more mysterious to the savage, who can interpret it only as a revelation of the divine nature within. Thus to man in a state of nature, all is inspirited, divine; everything speaks. The roaring of the wind, the cry of the animal, are voices of terror to him. He takes a pebble with him by chance and succeeds in his enterprise: the stone becomes the good spirit of his life.

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[1] *Menschen u. Thierseele*, II, lect. 44, p. 262.

Fetichism rests then upon a *post hoc ergo propter hoc.* One event follows another; the second is caused by the first. It rests upon a perpetual fear of fate—fate which to the ignorant is the will of harsh and jealous gods and is transformed by worship into an artless egoism. The idea that man creates his own destiny belongs to modern civilization, and is one of its noblest products.

In fetichism, the supernatural power is embodied in phenomena; the god is not yet become a distinct entity. An advance upon this is seen in the worship of spirits and phantoms. Throughout the vast country that stretches from the Ural to the sea of Japan, and from the Himalayas on the south to the Arctic Ocean on the north, we find this belief dominant—among the Tartars, Mongols, the nomadic tribes of Siberia, and the dwellers on the banks of the Obi and Yenesei. Shamanism, as it exists among the Ostiaks, the Samoyeds, the Jakuts, &c., is another form of the same. This belief, as Wundt says, has been properly called the *Religion of the Steppes.* In the sandy plains of upper Asia, arid and waterless, everything conspires to hallucination. The plaintive groanings of the storm are mingled with the cries of wolves and tigers; the eye wanders continually over immense wastes, while unknown noises strike upon the ear. Man, wasted with hunger and thirst, prey to burning fever, peoples these deserts with fantastic forms, born of a diseased imagination.

Thus worship consists always in the production of ecstasy within through artificial means. The Shaman priests, and the sorcerers of Finland and Lapland, dance before the fire, beating drums with savage cries. And the priest throws himself upon the ground when his ecstasy is at its height. Two men tie a cord around his neck and draw it to the strangling point, when he awakes and relates what the spirit has said to him.

This need of communication with the so-called supernatural world by means of hallucination and ecstasy, has existed everywhere: it explains a great number of facts often badly understood in the history of religions. In Greece the mysteries of Samothrace and Eleusis, the Dionysia with their dances and orgies, their seas of wine, and furious cries, were originally only a violent means to ecstasy. Wine had the same part as opium in the south of Asia, hashish in the north of Africa, and the taboo in the islands of the Pacific. In India and later among Christians, fasting and asceticism served the same end and produced a morbid excitation of the nervous system that passed for a revelation from the other world. The Christian can not understand the ecstasy of the drunken Bacchant; but the macerations of the hermit are part of his solitary orgy; and monks and nuns, on their part, ardently clasp in their arms fantastic images of the Virgin and Saviour.[1]

To what conclusions points this rapid review of facts in the domain of religion? It shows first, that religious sentiment, which ought to have some necessary basis of knowledge, rests sometimes in the imagination, sometimes in the reason. Thence it comes, says Wundt, that all polytheism is monotheism and all monotheism polytheism. The simplest religions, as that of the natives of America, speak of "a great Spirit;" that of the negroes of the "great Friend;" that of Polynesia, of a Creator of the world, &c. On the other hand, India has its Trinity; Christianity, its deified saints. Among the Jews, Jehovah is the national god, but his existence does not exclude strange gods; later, moreover, the rabbins imagined angels with different theistic functions. Religions differ then in this, that sometimes a god disappears before the gods, sometimes the gods disappear before a god: a fact that is explained by the pre-eminence sometimes of poetic imagination, sometimes of philosophic reflection.

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[1] *Menschen u. Thierseele*, II, p. 286.

In short, religious sentiment arises from two sources: observation of nature and consideration of destiny. Observation of nature leads to the worship of natural force, calm or violent. The uncertainty of destiny leads us to attribute marvelous virtue to objects around us. Imagination gives form to the gods of nature and destiny. But while it peoples its domain with more numerous forms, reflection works the contrary. It simplifies, unifies. It refers all the gods of nature to one alone, all the gods of destiny to a single Fate, and then unites the two conceptions in one, a first cause.

We have called feeling the forerunner of knowledge. Religious feeling points out the road to knowledge, to the highest knowledge that man can make his own: the cause and the destiny of the individual and the universe, as far as they are realized in the world. But it attains strength only as it is based upon science. Alone it is weak, for it is only conscious knowledge that can give authority to feeling and set limits to the imagination.

X.

WUNDT—THE WILL.

The will, like consciousness, is incapable of exact definition. To say that a conscious activity rules our internal states and external movements helps us little, since the very idea of activity is furnished altogether by our voluntary acts. The will to Wundt (leaving out for the moment the question of liberty) is a primitive state, fundamental to the essence of the individual. Instead of considering feelings and impulses (*Triebe*) as the first stages in voluntary development, we must place the will as primal fact and birthplace of feeling and impulse.[1]

Voluntary activity is internal and external.

As an internal activity it is confused with apperception, and is in fact only a form of the same. "In the will, the subject knows his own act immediately." "What we perceive in us in simple passive apperception is in part representation, in part the feeling of an internal activity that grows with the intensity of the representation. Active apperception is distinguished from this simple phenomenon only in that it is accompanied by the consciousness of a plurality of disposible representations, whence result qualitative changes in the feeling of internal activity, according as the intensity of one or another representation is increased."

As to the external activity (manifested in movement) the author maintains that it does not result from education, groping, and happy accidents, by which the will discovers that the body is obedient to its commands, but from the direct apperception of representations of movement. "Internal activity of the will is given from the first in consciousness, for we have no consciousness without apperception: the external act appears as the realization of the will. Considered as a simple phenomenon of consciousness, the external activity of the will is from the first only the apperception of a representation of movement. The real movement which follows, and the subsequent effect that it produces in consciousness and apperception, is a secondary consequence, not depending exclusively upon the will. The apperception of a representation of movement may take place without the real movement, when the organs are diseased or hindered.”

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[1] *Grundzüge* : II, sect. 5.

As to *choice*—it is a state of the mature consciousness in which the number of voluntary impulses is greatly increased, and there is either such equilibrium as to prevent the external action or, while one prevails, the external activity that manifests it is accompanied by the idea that instead of the prevailing impulse another might have determined the will. “In this idea is the consciousness of liberty.”

This is a subject of endless debate.[1] But the advocates of liberty and their adversaries might fight eternally, seeing that each party occupies its own peculiar ground and never leaves it. It is said on the affirmative: I have an internal feeling of liberty, therefore I am free. On the negative: Everything is subject to law, therefore liberty is an illusion.

Consciousness, says Wundt, tells us one thing: that we are able to act without internal or external compulsion; it does not tell us that we can act without cause. Determinists are wrong in saying that the will is subject to cause, therefore to compulsion. Their adversaries are wrong in saying that the will is not compelled, therefore is without cause. Cause and compulsion are different ideas. Compulsion exists only where there is resistance. We can not say that the earth is compelled to move, but we can say that a man is compelled to die. Yet both are subject to natural law. Where is the difference? The difference is, that man, as a conscious being, fears death and strives against it.

An important point we know—that every voluntary act has its cause. Although we are ignorant of the cause, it is unreasonable to deny it and conclude, as is sometimes done, that the will is a first cause, a *primum movens*. Consciousness reveals facts to us of which this takes no account. But are the utterances of consciousness sufficient?

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[1] *Menschen u. Thierseele*, I, II, lects. 55 and 56.

Let us look at these facts and see what they reply. No one will deny that social phenomena—marriage, divorce, suicide, murder, theft—emanate from the individual will. They are but the total of the actions of individual men. Statistic records these facts, classifies and interprets them. And what does it teach? Open the *Physique sociale* of Quetelet, and you see that social phenomena recur with astonishing regularity: the number of thefts, crimes, misdemeanors of all kinds, marriages, etc., is approximately the same for successive years in the same country. Thus in Belgium, during a period of five years (1841–45), the mean of marriages was 2642; the extreme deviations being + 46 and — 136. In France, during the long period from 1826–1844, the number of criminals each year varied from 8237 to 6299. In London during the period 1846–1850, suicides varied from 266 to 213. Further, the very variations, if we examine them, can be referred to exact causes. It is proved that famine increases the number of crimes, diminishes the number of marriages. A great epidemic, like cholera, diminishes the number of marriages, but when the scourge is passed, we note a proportional reaction and increase.

Evidently, then, social phenomena and consequently individual actions are subject to determinate causes. But it must be remembered that in dealing with great masses the statistician eliminates causes which act upon the individual. He proceeds, like the physicist, to collect a great number of cases in order to eliminate accidental influences. The physicist neglects these accidental influences because they are of no importance to him. Even the statistician proper may forget them. But the psychologist can not. When he asks whether there is in voluntary action beside natural and social causes, some *individual* cause, how can he neglect the small deviations, peculiar to individuals, which furnish exclusively the data for his study? Besides, statistic itself shows that crimes, misdemeanors, suicides, vary with age, sex, fortune, rank, etc. In proportion as we go into details, we discover more important individual causes. Yet we discover them only as *constants*. The individual fact in its totality can only be explained on the assumption of the existence of a *personal factor*. If we connect these two elements, we will have from the statistician the *external* cause and from the personal factor the *internal* cause of voluntary action.

This is the reply to the question put above. But what is this "personal factor" that is to be so strangely inserted in the series of natural cause and effect? It is a cause of an essentially complex nature which we may call by another name: *character*. "Character is the only immediate cause of voluntary action. Motives are mediate causes only. Between motives and character as causes there is this great difference, that the former are conscious or liable readily to become so, while the latter is *absolutely unconscious*." This personal factor is then "a dark point," as it were, in the brilliant light of causes, effects, and motives, which are all knowable and explainable by the general law of causation. Experience can not tell us immediately whether this personal factor is subject to universal causality or not. "When we say that the character of a man is a product of air and light, of education and circumstances, of food and climate, that it is necessarily determined, as every natural phenomenon, by these influences, we draw an entirely undemonstrable conclusion. Education and destiny imply an earlier character, to be determined: we take for effect that which enters earlier as part of the cause."

Pushing the question to its limits, Wundt remarks that there are two possible hypotheses on the nature of this personal factor: either character is a new creation in each individual; or it is the product of conditions inherent in earlier generations. The first accords with the doctrine of fixity of species; the second with the theory of evolution. On the second theory, the germ of character would not be the product of a free unintelligible Will, blindly distributing its gifts; but it would result of necessity from the constitution of the parents and the conditions of generation.[1]

The problem of the origin of character is thus referred to the question of psychic heredity, that is, definitely to a fact of necessity. But this question is beyond the limits of experimental psychology, and we return to our earlier position that the will is a particular aspect of apperception.

XI.

CONSCIOUSNESS.

All the states of which we have now spoken, perception, representation, idea, feeling, volition, form the continuity called consciousness, of which only tautological definitions can be formulated. Its fundamental characteristic, given in experience, is unity: its condition, that mental facts be united and co-ordinated according to law.

The physiological basis of the unity of consciousness is the continuity of the nerve system, and this excludes the possibility of diverse kinds of consciousness. We can not admit a determined *organ* of consciousness, in the ordinary sense of that word, for each region of the nerve system has its influence upon representation and feeling. Yet investigations on the nerve systems of the higher animals show that the gray matter of the brain is more intimately connected with consciousness than other parts. For there, not only the different sensor and motor peripheral regions, but the connections of the second order in the cerebral ganglia, cerebellum, &c., are represented by special nerve cords. It is, therefore, the peculiar function of the cortical layers to connect immediately or mediately, all the states of the body whose function it is to awake conscious representation. In this sense only can we say that in the case of man and probably of all the vertebrates, the cortical layers of the brain are the organ of consciousness, yet without forgetting that the function of this organ presupposes the subordinate central parts (corpora quadrigemina, optic thalami, &c.), which give, in all probability, the synthesis of sensation.[1]

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[1] *Grundzüge*, II, p. 394.

Considered in its psychological aspect, consciousness is a unification, an activity that essentially unites, combines. Two principal phenomena show it forth: the formation of representations from impressions; the succession of representations.

Each representation appears to us as the combination of a plurality of sensations. For example, we assign to each color its place in space, we co-ordinate it with a certain number of accompanying visual sensations. Pure sensation is an abstraction which never enters into consciousness. Yet psychological and physiological analysis constrains us, none the less, to maintain that it is by a synthesis of sensations that our representations are formed. We must, therefore, consider this fusion of elementary sensations in every act of representation as the characteristic mark of consciousness.

Further, the succession of representations is given immediately as cohesion, resting upon the internal and external conditions of representation. Their reproduction and association are necessary manifestations of consciousness. A connection of representations disposed according to law—this, from the psychic side, is the form under which we know consciousness.

We have seen that Wundt maintains, by analogy with the distinction established by physiologists between the visual *field*, which is large but vague, and the visual *point*, which is small but exact, that there is a distinction in consciousness between perception and apperception. That which enters consciousness in a general way is *perceived*, that to which the attention is directed is apperceived. Attention marks then the most exalted moment of the mental life. Subject to external or internal, physiological or psychological influences, it is always accompanied by a feeling of tension. So that, taken as a whole, the act which physiological psychology seeks to interpret, embraces the following moments: impression, transmission to a nerve centre, entrance into the field of consciousness, passage to the particular point of apperception, voluntary reaction, transmission by the motor nerves.

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[1] *Grundzüge*, lect. 4, ch. 15.

It is impossible, without extending beyond bounds this study already so long, to follow Wundt in what he says on movement, language, morbid states of consciousness, and animal psychology. It must suffice to have indicated his method and shown the variety of questions treated. It remains to speak of his experimental work: to this the next chapter is devoted.

We can not conclude this exposition, however, without saying some words upon the theories recently put forth by Wundt in his *Logik*, and showing in what measure they modify or supplement his earlier work. Their influence is seen most strongly in the important part assigned to the activity of apperception, of which we have already said so much.

States of consciousness may be considered as depending immediately upon the organism, and their study, therefore, belongs to psychophysics and physiological psychology. Their ultimate law is that of association, analogous to the laws of physics.

But apperception, as indicated above, is identical with the will, in a sense autonomous, and gives unity to representations or states of consciousness: it is a synthetic principle. To it the concept of the soul is ultimately reduced. There are only two ways of conceiving the soul, says Wundt; as a substance and as an act. To the first conception belong all the theories according to which psychic facts are manifestations of a hypothetical substratum, a substance material or immaterial. According to the second, the psychic is pure actuality, immediately given in the manifestations of the mental life. Hume, Kant, Fichte and Hegel are representatives of the theory of actuality. Psychology cannot, like the physical sciences, attach to itself a metaphysical concept outside the fact of internal perception, or allow itself to be embarrassed with the useless hypothesis of a substance, to hinder all progress in the explanation of phenomena. Internal activity can not be compared with external activity, as experience reveals it to us, although we use the same word for both. It is not a simple happening; it is an apperception; our acts of logical thought are always connected with an immediate feeling of spontaneity. And this spontaneity is not something external to the activity or distinct from it; they can be logically separated, but not in fact.

We indicate this theory very summarily, for it leaves the sphere of purely empirical, and leads to general psychology.[1]

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[1] See a detailed exposition in the article of M. Lachelier, already cited.

CHAPTER VII.

DURATION OF PSYCHIC ACTS.

I.

ALTHOUGH not exclusively their work, the researches we are about to consider in this chapter are largely due to German physiologists. Commenced by Donders less than twenty years ago, a series of memoirs has since been published, of which the latest dates 1877.

The problem of the duration of psychic acts seems to indicate most clearly the course that psychology must pursue to become an exact science. Considered in its essential points, the method of procedure consists in: choosing a well-determined question, gathering the immediate data of consciousness upon it, interpreting these by means of reflection, on the part of self and others, and, finally, attaining, if possible by actual experiment and measure, a truly scientific, objective, and verifiable statement of the time period.

The common fact which serves as point of departure is this: we think sometimes faster, sometimes more slowly. It is a matter of universal consciousness. In times of excitement, anger or dread, our ideas are precipitated like a torrent, rushing together as in a storm, and the triteness of the figure indicates our familiarity with the fact.

But reflection goes further. If accustomed to analysis, we are able to submit to delicate examination these violent states and their contraries, ennui, *tædium vitæ*, weariness in the mental life. We can study especially facts which are less subjective in character and more open to analysis. Thus it has been ascertained that the rapidity of thought is prodigious in dreams,[1] delirium, some forms of madness, as acute mania. On the other hand, thought is sluggish with the idiot, the half-witted, and in certain kinds of paralysis. The ideas of such patients are so disjointed that any one can perceive it at once. These and kindred facts are of great scientific interest, and throw light on many questions. They show, for example, that our subjective appreciation of time depends entirely on the rapidity or slowness of our thought. When Thomas de Quincey, the celebrated opium eater, increased his usual dose, he believed "that in one night he had lived a thousand years, or, indeed, a length of time that exceeded the limits of all human experience."

We may go still further. Instead of these estimates of the internal sense, which are always vague and are applicable only to a series of states, we propose to measure the individual state of consciousness in its duration and with its variations, by means of exact apparatus.

This work is recent, and, as may well be believed, very far from complete. Not to speak of the great difficulties which the experiments present, there have been many prejudices to overcome. Müller himself considered every attempt of this kind chimerical: and the first suggestions came not from physiology, but from a science that seemed completely foreign to studies of this kind, astronomy. For a long time, too, these suggestions were not taken up.

In 1795, Maskelyne, astronomer in the observatory at Greenwich, noticed that his assistant Kinnebrook always noted the passage of stars across the meridian from 0.5″ to 0.8″ too late, and thinking such negligence inexcusable, discharged him. Later, about 1820, Bessel, while comparing his own observations with those of other astronomers, especially Struve and Argelander, found that they were always in advance of himself, and in his search for the cause of this difference, discovered the personal equation. According to the method of Bradley, then used in the observatories, a telescope was employed in which was stretched a thread so fine that the exact instant of the transit of the star in question could be noted. A pendulum beating seconds was used for the observation. The observer had then to unite two sensations of distinct orders, one visual, the passage of the star, the other auditory, the beat of the pendulum. Yet this would be simple enough if the sensations were simultaneous; but this occurs rarely and by chance, the beat of the pendulum very seldom coinciding with the passage of the star. In fact this is what occurs:

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[1] For the facts on this subject, see Maury, *Le Sommeil et les Rêves*, chap. V, pp. 138, 139, and Brierre de Boismont, *Des hallucinations*, observation 77.

•*e* M• •*e′*

Suppose the thread is at M; the first beat of the pendulum is heard when the star is at *e*; at the second beat the star has crossed the meridian and is at *e′*. To give the exact instant of its passage the astronomer must estimate the distance *e* M, as, for example, two-thirds of *e e′*, the distance passed over in one second. It is in this subjective estimate that observers differ.

Differences due to the personal equation sometimes amount to more than 1 second, but oftener fall below 0.3″.[1] They vary with hours of the day, the momentary feelings of the observer (circulation of the blood, nervous fatigue, &c.), and may be reduced, says Wolf, by attention and habit, to 0.1″. Bessel explains these differences by saying that a visual and an auditory impression can not be simultaneously compared, and that two observers require different lengths of time to superpose the two impressions. He adds with reason that the difference is greater still if one observer passes from sight to hearing and the other from hearing to sight. Yet he does not seem to assign a great enough part to *memory*. The comparison is really made not between sensations of different orders merely, but between present facts and past facts (for example, the position of *e*). "It is certain," says Wolf, "that at the moment of the passage, the observer does not hear the stroke of the pendulum, but an internal stroke which his thought substitutes for it, just as the musician does not wait for the stroke of the director's baton, but catches himself the rhythmic advance of the measure. This is no more the superposition of two sensations from without." The fact that memory intervenes here is very important for the psychologist. It indicates the possibility of a comparison in duration of a present state with a past state. Thus we see, from this case, that a longer time is needed for the reproduction of a state of consciousness than for its production.

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[1] The difference between Bessel and Argelander was considerable, and the regularity of the variation is interesting. This difference for instantaneous phenomena was 0.22″; with a pendulum beating half seconds, 0.72″, that is, 0.5″ + 0.22″: with a pendulum beating seconds, 1.22″, that is, 0.5″ + 0.5″ + 0.22″. For details, see Wolf, *l'Equation personelle, ses lois, et son origine*, 1871, and Radau, *Moniteur scientifique*, Nov. 15, 1865, et. fol.

After astronomy, physiological experiment opened the way for new research. In 1850, Helmholtz, carrying out a program of experiments suggested by Dubois-Reymond some years previously, measured in an exact way the time of the transmission of nerve action through a given nerve length. He excited the nerve near the muscle with which it acts and noted the time between the excitation and the contraction. Then repeating the experiment at a point more distant from the muscle, he found the time longer. This retardation gives data for calculating the velocity of nerve transmission.

The experiments of Helmholtz have been taken up by different scientists, Dubois-Reymond, Marey, Hirsch, Schelske, Jaager, Baxt, &c., &c., who have studied nerve transmission with simpler apparatus, and in the most varied conditions, and have experimented upon sensor as well as motor nerves.[1]

These experiments are only an introduction to the problem before us: the measurement of the duration of psychic acts. Yet they do more than indicate the route: they furnish the elements essential to the calculation. Let us mark well the conditions of the experiment. The subject feels a sensation and exhibits it in a reaction, a movement. Sensation, the initial moment, and movement, the final moment, are alone accessible to our methods of measurement. A period of time elapses between the two, of which part is occupied with centripetal and part with centrifugal nerve transmission. These two periods being known, the duration of perception, the psychic act proper, becomes more easily accessible.

The direct measurement of this duration was attempted about 1861 by different experimenters, particularly Donders. He remarked first that the *physiological time*, that is, the interval between the excitation and the sign of reaction, varied according to the excitation employed. If it be a tactile impression—pricking the hand with an induction coil—the reaction takes place after $\frac{1}{7}$ second. If it be an auditory impression, $\frac{1}{6}$ second. For a visual impression, the time is further lengthened to $\frac{1}{5}$ second. To determine exactly the duration of the psychic act alone (perception and consequent volition), deduction must be made of the time necessary for nerve transmission. Donders and Jaager contrived various experiments with this in view.

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[1] A *résumé* of results is to be found in the last edition of Hermann: *Grundriss d. Physiologie des Menschen*, 5th ed., Berlin, 1874, pp. 304–306. Hermann gives as the true mean of transmission in the sensor nerves of man 62. 9 m. a second. For work since done in France, see Ch. Richet. *Recherches expérimentales et cliniques sur la sensibilité.* Paris, 1877, p. 62, &c. Bloch, *Archives de Physiologie*, 1875, p. 588, &c.

The method employed is briefly this: the subject is told that he is to receive an electric shock in the right foot, and that he must react with the right hand; the physiological time, as we have seen, is $\frac{1}{7}$ second.

The experiment is repeated under new conditions. The subject does not know which foot will receive the shock; but he is to react with the hand on the same side. A certain indecision results. In this case, the physiological time is longer than before.

We have here an extremely simple psychic act, since it is reduced to a comparison of two perceptions, one real, the other possible, and an action in consequence. This experiment shows that the most elementary state of consciousness has a measurable duration. Donders applied the same process of experiment to visual and auditory impressions, and reached analogous results.

These curious investigations were continued by Helmholtz, Mach, Vierordt, Baxt, and more recently by Exner (of Vienna), in an important paper bearing the title: *Experimental Investigations on the simplest psychic Processes*.[1] This physiologist makes use of sudden electric impressions on the skin, retina, etc. On a cylinder wrapped with charcoal paper, the excitation is first recorded, and then the reaction of the subject, by sudden pressure upon a lever. An interval separates the two records on the charcoal, and as the circular velocity of the cylinder is known, the time of the reaction can be calculated nearly to the ten-thousandth of a second.

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[1] *Experimentelle Untersuchungen der einfachsten psychischen Processe* in *Pflüger's Archiv*, 1873, vol. VII, pp. 601–609. The instruments used to measure the duration of psychic acts vary with different experimenters. One may use the chronoscopes of Pouillet and Hipp, or the registering apparatus of Krille, Hankel, etc. For descriptions of them, see the works cited, and particularly Marey, *Du mouvement dans les fonctions de la vie*. For the other authors cited, see Mach, *Sitzungsberichte der Wiener Akad.*, vol. 51, p. 142. Vierordt, *Der Zeitsinn nach Versuchen*, 1868. Baxt, *Pflüger's Archiv*, vol. IV.

Exner, whose results we give later, has studied with care the accidental conditions of the physiological time. Above all, the degree of *attention* has a very marked influence. The greater the attention, the shorter the time; when attention is at its maximum, the time is at its minimum.

The time varies also according to the organ affected, and the point of the body to which the excitant is applied.

Age has an influence. Exner found the minimum of time = 0.1295″ for a young man of twenty-two years; and the maximum = 0.9952″ for an old man of seventy-six years.

The experiments of Wundt must be added to those of Exner. In his *Physiological Psychology*, he has gathered together the work of his predecessors and added his own. We will take him as guide in the following exposition. In fact, we find in him, as is rarely the case in such study, at once the physiological data and their psychological interpretation.

We may mention finally the recent investigations (1877) of J. von Kries and F. Auerbach, which, as we will see later, deal with a special point: the time of "discernment," that is, of the intellectual act alone.

II.

We must notice, from the first, that the time which elapses between the excitation and the reaction involves several phenomena of different kinds. Exner, who has analysed it very minutely, finds in the whole time the following moments:

1st. Time occupied by the transformation of the force of excitation into nerve force (zero when the nerve is directly excited).

2d. Time occupied with the transmission of the excitation through the nerve to a nerve centre.

3d. Time occupied in transmitting the excitation through the spinal cord (zero for the cranial nerves).

4th. Time necessary for the transformation at the centres of the impression into motor excitation.

5th. Time of transmission of motor excitation through the spinal cord.

6th. Time of transmission through the motor nerve.

7th. Time necessary to muscular contraction.

Of these different elements, it is the fourth which concerns us. The others are known, determined—except the first, which has been studied for the retina only, and without conclusive results.

Wundt, who has also made an analysis of physiological time, shows that for psychological purposes, these different elements may be reduced to two principal moments.[1] The physiological time, as a whole, comprises: 1st, transmission by the nerves to the centres; 2d, entrance into the visual *field* of consciousness or perception; 3d, entrance to the visual *point* of consciousness or apperception; 4th, time necessary to volition; 5th, transmission by the nerves to the muscles.

The first and last of these elements may be considered purely physiological. The others are psycho-physical in their nature. We have reason to believe, says Wundt, that the impression which acts with sufficient force upon the central parts, enters thereby into the visual field of consciousness. A special effort, felt within, is necessary to give attention to this impression, and it is by this effort that apperception is distinguished from perception pure and simple. The duration of perception is thus contained in the duration of the sensor transmission:

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[1] *Grundzuge*, chap. XVII.

it is at once the last act of the physiological fact, and the first act of the psychological fact. By duration of perception we must therefore understand both the time of the excitation of the sensor nerve centres, and the time of the entrance of the impression in the field of consciousness.

On the other hand, the time of volition is connected in the same way with the time of the motor or centrifugal excitation. It is a contradiction of facts to maintain that an act of volition may be completely accomplished before the motor excitation of the nerve centres begins. The internal sense, at least, gives us the two facts as simultaneous.

Thus the excitation of the sensor centres and perception, the excitation of the motor centres and volition, are given each as a psycho-physical fact. There remains another element: apperception, which seems at first to be purely psychological. But it is not so. Without stopping to examine the different hypotheses that may be urged upon the nature of this state, it is certain that it is always accompanied by a feeling of tension or effort; and this feeling has necessarily, as physiological basis, a fact of central innervation. In many cases it is impossible to distinguish certainly apperception from volition, as to duration. We may, therefore, comprehend them under the common term duration of reaction, since each consists in a central reaction against the perceptions which enter consciousness.

To sum up, then, the physiological time is finally resolved into two physiological facts—sensor transmission and motor transmission—and two psychological facts, duration of perception and duration of reaction. The time of transmission is known. It is more difficult to determine the relative duration of the two internal acts. Yet it is done by experiments designed to complicate or facilitate the acts of perception and reaction, and indicate in what cases the variations in duration are to be attributed respectively to either of these psychological acts. There is a last *desider-*

atum, involving new and often impossible research: to decompose the duration of reaction into two parts, apperception and volition.

The *status* of the problem having been well indicated, let us enter now into the detail of experiment and its results. We may group the different cases studied under the following heads:

1st. Impression known but not determined as to the time of its appearance.

2d. Impression known and determined as to its time.

3d. Impression neither known nor determined as to its time.

4th. Impression accompanied or followed by another impression sometimes like, sometimes unlike.

5th. Regular series of perceptions in which a new perception is intercalated.

6th. Mixture of internal states and perceptions, allowing the measurement of the duration of these psychic acts during reproduction.

7th. Duration of discernment, that is, of the most simple intellectual act taken alone.

I. We will examine the first case. The subject of the experiment knows that he is to experience a tactile, visual, or auditory sensation: all his attention is concentrated on a single undetermined point, the instant of its appearance. In this case the physiological time is about ⅕ second. It is a little shorter for impressions of touch and sound than for sight. The experiments of Wundt give the following numbers:

Sound	0.167	or	about	⅙.
Touch	0.213	"	"	⅕.
Sight	0.222	"	"	⅕.

The mean figures given by other observers, Hirsch, Hankel, Exner, Auerbach, and Kries, are:

Sound . . . . 0.149, 0.1505, 0.1360, 0.122, 0.120.
Touch . . . . 0.182, 0.1546, 0.1337, 0.146, 0.117.
Sight . . . . 0.200, 0.2246, 0.1506, 0.191, 0.193.

But, as Wundt remarks, the excitants employed to produce the three orders of sensation are far from being of the same intensity. We have no means of comparing things as dissimilar as a noise and an electric spark. Yet differences in duration may be due to differences in the intensity of the objective cause. To solve the problem, the sensations compared must be referred to the point at which they reach the "threshold of excitation," the perceptible minimum;[1] for there they are equal in consciousness. Setting out from the perceptible minimum, Wundt obtains the following figures, as mean result of twenty-four observations:

Sound . . . . . . 0.337 . . mean variation, 0.0601.
Sight . . . . . . 0.331 . . " " 0.0677.
Touch . . . . . . 0.327 . . " " 0.0324.

He concludes that the conditions of nerve transmission remaining the same, "the duration of perception and reaction is constant when the excitation is at its minimum." Experiment shows further that the physiological time diminishes in proportion as the intensity of the excitation increases. He has two pieces of apparatus, one a ball weighing fifteen grams let fall upon a surface, the other an electro-magnetic hammer, with which, when the height of the ball and hammer and, consequently, the intensity of the sound that their fall produces are changed, he obtains the following results:

Height of ball.	Time.	Height of hammer.	Time.
0.02 m	0.161.	1 mm	0.217.
0.05	0.176.	4	0.146.
0.25	0.159.	8	0.132.
0.55	0.094.	16	0.125.

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[1] This expression threshold of excitation (*Reizschwelle*), used so much in contemporary German psychology, has already been explained.

These two series of experiments show clearly the inverse ratio, already enunciated, between the intensity of the excitation and the physiological time. Without doubt the time of nerve transmission enters here. It increases with the intensity of the excitation; but the quantity by which it increases is so small compared with the total physiological time, that it is necessary to carry the difference to the reckoning of the perception and reaction.

How is the physiological time to be divided between perception and reaction? It is difficult to say. Yet the conditions of the experiment throw light upon the question. In cases of minimum perception one finds himself, at least in many cases, in a state of doubt which lasts a certain time; he asks, with indecision, whether an impression has really been made, and feels clearly that this indecision takes a given amount of time. Now it must be remarked that a state of this kind arises not only in cases in which the judgment is suspended, but also in cases in which the impression is clearly above the perceptible minimum.

In what relation, then, as to duration, are the two elements (apperception, volition) which are included under the term duration of reaction? In some cases they exist in consciousness as two successive acts, but they are nearly always given simultaneously in one and the same indivisible moment. Yet it can not be denied that the conditions of the experiment render very probable this conclusion, *i. e.*, that the duration of volition is very small and the larger part of the reaction must be attributed to apperception. The conditions of the experiment are in fact such that the register is made with mechanical exactness, and, while the attention is concentrated upon it, the voluntary impulse is almost instantaneous.

Another fact in favor of this conclusion is this; it sometimes happens, that, when an impression is eagerly expected, an entirely different impression is registered (light instead of sound); and it is known at the very moment the movement is made, that the mistake has been committed.

II. The foregoing experiments may be simplified by placing the subject in conditions such that his effort in attention is ruled out. To do this, it is only necessary that the character of the impression he is to experience be entirely understood, and all cause for indecision removed. He knows beforehand the nature of the sensation (sound, light, etc.); further, its appearance is announced to him by a signal. Thus a luminous or auditory impression is preceded by the beat of a pendulum that indicates to the subject the exact moment at which the impression is to be made.

The physiological time is then considerably *diminished.* With the use of the ball spoken of above, which, by a simple arrangement, can be made to strike a ring before or after its fall, and thus produce a sound, Wundt establishes the following differences:

			Number of experiments.
Fall of 0.25 m:	without signal,	0.253	13
	with signal,	0.076	17
Fall of 0.05 m:	without signal,	0.276	14
	with signal,	0.175	17

The experiment shows that when the constant interval between the signal and impression increases, the physiological time diminishes. Further, repetition and habit have a very great influence upon this diminution. In a long series of experiments, the external conditions remaining the same, the physiological time grows very small (some thousandths second), perhaps zero.

The diminution of the physiological time is explained by the extreme state of attention: it prevents all delay in the perception and reaction. But how can this time become zero? In actual experiment, all cause for indecision being removed, the subject tends to make his movement of reaction coincide exactly with the impression perceived, and this is accomplished after repeated attempts. In certain cases, the attention is so active that the impression is perceived *before* it actually takes place, and as the state of motor innervation is at its maximum, the reaction follows the perception immediately.

Exner remarks that in such rapid experiments, the practiced subject knows very well whether his register is good or bad, although the difference felt in such a case be not more than some hundredths second; and he knows it by the difference of interval which he perceives between the impression and the movement. This shows what extraordinary precision the internal sense may attain in investigations of this kind.

III. Instead of simplifying the experiment, as in the preceding case, we may complicate it.

The case of least complication is this: the nature of the impression is known, but the moment of its appearance and its *intensity* are unknown. Suppose there is a single auditory impression, and intense and feeble sounds follow without rule. In this case, the physiological time is always increased. Wundt made two series of experiments, one with uniform changes, the other with changes without rule:

	I. Uniform change.	II. Change without rule.
Intense sound	0.116	0.189
Feeble sound	0.127	0.298

The physiological time is further increased when a feeble sound is suddenly intercalated in a series of strong sounds, and *vice versa*. The duration may reach 0.4 to 0.5 second. In such cases, the differences can be attributed neither to the duration of the perception, nor of the transmission, but to the duration of the *reaction*. This duration increases because the conditions of the experiment are such that the attention is taken off guard; the earlier effort to simplify the work of apperception is wanting. In fact, the conditions of innervation are the same here as in the other experiments; so that the difference must be looked for elsewhere.

A more complicated case than the preceding arises when the impression is entirely unexpected. Its result is a lengthening of the physiological time. This case arises sometimes accidentally, when the subject, instead of giving attention to the expected impression allows it to be diverted. It may be produced artificially by breaking in upon a series of long intervals with a very short interval. The physiological time is then lengthened to ¼ or ⅓ second.[1] The lengthening is least, although still noticeable, when the subject does not know the nature of the impression he is about to receive, whether sound, sight, or touch.

It is possible, finally, to occasion complication not in the impression felt, but in the movement of reaction. Such are the experiments suggested by Donders and Jaager, of which we have spoken above. An electric shock is given sometimes to one foot, sometimes to the other, and the hand on the side affected is to react. Or the impression is produced by a light, sometimes red, sometimes white, and the right hand is to react for the former, the left for the latter. Finally, a third method: a vowel is spoken and the subject repeats it, the two movements being registered by means of a point moving upon a drum. Sometimes the vowel is known beforehand by the subject, sometimes not. The instrument shows the following differences of duration:

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[1] When an impression is sudden enough to occasion fear, the physiological time is increased, according to Wundt, diminished according to Exner.

Impression known.		Impression unknown.	Difference.
Touch . . .	0.205	0.272	0.067
Light . . .	0.184	0.356	0.172
Sound . . .	0.180	0.250	0.070

Yet it must be noticed that in these three series of experiments, the conditions of reaction are not the same. There is, in fact, a close association between an impression upon the foot and a reaction of the hand upon the same side, favored by anatomical conformation, exercise, habit, etc. It is the same between an auditory sensation and a vocal reaction. But this natural organic association does not exist between a sensation of red and a movement of the right hand.

It can, therefore, be concluded "that the duration of volition depends principally upon the physiological connections between the sensor nerve centres and the motor organs of reaction." When the reaction is favored by the mechanism of the nerve system and by habit, the time is due largely to apperception. In the contrary case, the time of volition plays the principal role.

IV. So far we have dealt with single impressions only. Let us see the result when, beside the principal impression which is registered and whose nature and intensity are known, another is produced in order to fatigue the attention.

We will take, first, two impressions of the same kind. Wundt employs a bell struck by a small hammer. He registers the impressions in the ordinary way. Then by means of an instrument arranged for this experiment, consisting of a toothed wheel in contact with a metallic thread, he produces a continuous sound; the differences are these:

I. Moderate sound:	without simultaneous sound,	0.189.
	with " "	0.313.
II. Loud sound:	without simultaneous sound,	0.158.
	with " "	0.203.

The increase in the physiological time is evident. It is the same when the two impressions are of different kinds:

Electric spark:	without simultaneous sound,	0.222.
	with " "	0.200.

When the sensations are unlike, the difficulty of attention is greater. We feel it harder to react correctly and experience a feeling of pain akin to embarrassment.

If the experiment be performed in another way, a curious result is reached. With the principal impression, let another be produced either simultaneously, before, or after.[1] Observation shows that the internal succession of perceptions can not correspond with the external succession of excitations: in other words, an excitation which is really later than another may be perceived before it. Internal observation leaves no doubt as to the cause of this illusion; it is due to the changing state of the effort of attention. When the effort is feeble, this never takes place; but when it is intense, a true anticipation in time may be occasioned.

We may remark, also, that in this kind of experiment the secondary impression, when it is *later*, has no influence upon the principal impression; all takes place as in simple conditions. It is the same in cases of simultaneousness. But if the disturbing impression is earlier, the physiological time is always increased, as the following experiments show:

Disturbing impression.	Sound.	Light.
Simultaneous or posterior	0.176	0.218.
Anterior	0.228	0.260.

When the experiment is conducted as before, with the difference that the accessory follows the principal impression by a very short interval, the method of observation changes. It is no longer necessary to register the perception of the principal impression by movement; the second impression, provided it belong to the same sense, serves to establish the duration of apperception for the first. For this, it is sufficient to vary the interval between the two impressions, and thus determine, by the experiment, the time taken by the second to efface the first. The portion of the duration of the reaction that belongs to the voluntary impulse disappears of itself.

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[1] The experiment may be made with two impressions of the same or of different kinds.

We can not call too much attention to the new process employed here. The period of physiological time is shortened since it includes but two principal elements, centripetal transmission and apperception; and the determination of the duration offers the simplest conditions. To understand clearly the mode of this determination, it must be remarked: that if two excitations are separated by an interval of time n (which is indicated by the registering apparatus), and if they are perceived as a single excitation, we can conclude that the first sensation has a duration equal at least to n. If the interval be increased by n' (giving, in consequence, $n + n'$), and if the subject now perceive two sensations, we can conclude that the first sensation has a duration less than $n + n'$. By causing n' to vary, we can determine, with sufficient exactness, the physiological time of the first sensation.[1]

Yet this method of experiment offers difficulties. Each impression leaves after it, in the organ, a certain residuum, a persistence of purely physiological action, which remains when the second impression is received; in short, this residuum lasts throughout the interval that separates the two simple impressions.[1]

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[1] Experiments designed to determine the velocity of sensor nerve action are based upon a similar principle. They eliminate, in the same way, the time of the reaction and rest upon the longer or shorter persistence of the sensation. See *Archives de physiologie*, 1875, p. 588, &c. These experiments, performed by Bloch, have given rise to various criticisms upon the method.

According to Baxt, the difficulty disappears when the principal impression is *composite* rather than simple. He uses letters and geometrical figures for the experiments. By causing the interval of time that separates the principal impression from the second which effaces it to vary several times, we find on repeated attempts the maximum interval between two excitations that will result in a single perception. Since, if acting alone, a momentary impression produces a sensation, we may assume that the interval answers to the duration of apperception.

But the time thus measured varies greatly and grows with the intensity of the second excitation. Working with different degrees of intensity, Baxt found that the time necessary to perceive three letters varied from [illegible] to [illegible] second. When he used, in turn, simple and complex curves the relation of their respective times was 1 to 5.

In these experiments, the excitations are produced in such a way that there is no *objective* interval between them; the first persists, when the second is produced: and yet, *subjectively*, we feel a small interval very clearly, during which neither of the excitations is clearly perceived. So that

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[1] According to Mach, the interval of time necessary for the separation of the two impressions is:

For the eye	0.0470 second.
For touch (finger)	0.0277
For the ear	0.0100

To be complete, we will add that according to the researches of Vintschgau and Hönigschmied, published in *Pflüger's Archiv* (vols. 10 and 14), the duration of taste excitations is from 0.15 to 0.23 second. It varies with the point of the tongue excited and the nature of the sapid substance: salt, sweet, acid, bitter, representing a series of lengthening duration.

while there is continuity in the causes of our perceptions, there is discontinuity in the effects. This character of *discontinuity* presented by the order of our internal states arises, as Wundt remarks, from the nature of apperception. It takes time to transfer the attention from one impression to another. As long as the first endures, our effort is directed toward it; even at the moment that the second appears, the attention is not predisposed to observe it. There is, therefore, a certain period during which the attention diminishes for the first and increases for the second: this period seems vacant and indeterminate to us. There are three possible forms of perception in the case of two given impressions which are really simultaneous or nearly so: simultaneousness, continuity, discontinuity. If we perceive them as simultaneous, they are for us integral parts of one whole: they constitute one object. If not, we *always* perceive them as discontinuous, under the *discrete* form of time: and this form, as we see, has its source in the very nature of the act of apperception. Continuity arises only from variations of intensity in one and the same representation, never from the juxtaposition of two.

V. If we suppose a series of perceptions of the same kind proceeding in regular order and their interruption by the intercalation of another impression, to which term of the series will apperception attach this new term? Will the two impressions which are simultaneous without be simultaneous within?

The terms of the series and the new term interposed are either homogeneous or heterogeneous.

In the former case, as, for example, when a luminous excitation enters in a series of visual representations, a sound in a series of sounds, a derangement in the apperception of the series may result, but it will be very light, and restricted to extremely narrow limits. All takes place as though there were but two isolated impressions: the difference between the union of representations and the real union of impressions is nothing or very small.

In the second case, all is different. To show this, Wundt intercalates a sound in a series of visual impressions, in the following manner. On a graduated scale, an indicator is moving uniformly; and it is placed in such a position that the place of the needle can be seen very clearly at each moment. The action of the clock which moves the needle gives forth a sound at any desired time; in such a way that the subject never knows beforehand when he is to hear it. In this experiment, one of three things must happen:

1st. The auditory impression is perceived at the exact moment when the indicator is at the point answering to the sound: in this case there is no derangement or lengthening of time.

2d. The sound may be heard when the needle is farther advanced: the time of representation then undergoes a lengthening, to be called *positive* when the sound is heard later than its real time.[1]

3d. The sound may be connected with an indication of the needle earlier than its real position: this is called a *negative* lengthening.

In other words the sound may be heard exactly as it is emitted, too late, or too soon. It would seem at first sight that the positive lengthening would be more frequent, since apperception always requires time. Experiment, however, shows the opposite. By far the most frequent case is that of *negative* lengthening, i. e., we believe we hear the sound before it is really emitted. It rarely happens that there is no lengthening, either positive or negative.

For many years, Wundt has experimented on this point, varying the conditions, method, and apparatus. We can not explain his work in detail. The principal result, however, that he has reached, is this: when impressions which form a series are varied considerably, in respect to rapidity, the lengthening is *positive*, within certain limits.

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[1] In these experiments, it is, of course, necessary to take account of the difference in the velocity of sound and light.

The explanation of these facts is suggested by the experiments already examined. We have seen that the apperception of any impression takes a period of time; but that this period is shortened if the nature of the impression is known, and that it is further shortened if the instant of its appearance is known. We have shown that in such a case one of the results of extreme attention is that apperception may precede the real impression. Now the very conditions of the experiment before us must produce this *negative* lengthening with regular certainty. In fact, when the series of uniform impressions develops slowly, the attention, which is directed entirely toward the secondary impression (the sound), attains its maximum before this impression arises, and consequently is combined with a visual impression earlier than the real sound: so the sound is heard too early. On the contrary, the more rapidly the series of uniform impressions develops, the more difficult it becomes to realize full attention before the sound is produced; consequently the lengthening becomes less and less negative, then zero, then positive.

From all these experiments as a whole, Wundt concludes that apperception and voluntary reaction constitute a connected fact, whose physiological point of departure is found in the motor centres. He recalls to mind:

1st. That when apperception is not followed by a voluntary impulse (that is, when its duration is determined by means of an immediately succeeding impression), its duration is least.

2d. That when there is a natural or habitual relation between the impression and movement, apperception and volition coincide; and when a choice is to be made, the phenomenon is made up of two independent acts.

But, in any case, he maintains, the whole fact is to be referred to a voluntary excitation which is sometimes directed toward the sensor centres (apperception), sometimes toward the motor centres (volition proper). "Apperception and motor impulse are, therefore, only different forms of voluntary excitation. Hence it is that they are so intimately connected, and that they coincide in certain cases. A physiological fact that has hitherto been an enigma by reason of the common separation of sensation from voluntary reaction is greatly cleared up. It is probable that the anterior parts of the brain are centres of voluntary movement, while the sensor centres are located principally in the posterior regions of the cortical layers. On the other hand, we can doubt as little that the highest functions of mind are always involved in the development of the frontal portions. This becomes clear when it is remarked that this seat of voluntary innervation, is in itself the grand centre for all the peripheral centres, determining movement and the apperception of impressions.

VI. We now come to a different class of investigations. We have to deal not with the duration of actual sensations in consciousness; but with the time necessary for the *reproduction in memory* of past perceptions.

In fact, however, an absolute line of demarcation between present and reproduced perceptions is impossible; for traces of earlier impressions mingle with states awakened in consciousness by sense impressions, sometimes completing them, sometimes remaining distinct. Moreover, we have seen already in our study of the perception of impressions which are expected or foreseen, that reproduction plays a role there, and enters largely into the phenomenon of present perception.

Experiment shows that in general *the time of the reproduction of a state of consciousness is longer than the time of its production.* Yet this general statement, to be exact, must be modified in several ways.

Memory may represent the interval between two perceptions as longer or shorter than it is: longer when the interval is small; shorter, when it is large. Every one who is accustomed to reflection has noticed it. When we pass over in recollection certain periods of our lives, a short section always seems relatively longer than a long one. A month and a year are both shortened in memory, but the year is shortened more relatively.

This law may be established, also, by direct experiment. If we seek to represent to ourselves fractions of a second, such representations are always too great: and the contrary is the case when we represent minutes or hours. To study the duration of these small intervals, Vierordt causes the subject to attend for some time to the beating of a metronome; then he is to reproduce the beats as fast as he heard them. Now, the repeated intervals are too short when the real intervals are long, and too long when the real intervals are short. The individual variations on both sides of the exact point are large.

Vierordt concludes from his own experiments upon himself that the estimation and excitation exactly coincide, when the internal is:

For the ear	between 3 and 3.5 seconds.
For touch	" 2.2 and 2.5 "

He allows only a small interval between the sensation and its repetition.

The feeling of duration, as Wundt remarks, differs according as it is retrospective or prospective. In the former case, it rests on a reproduction of former states, in the latter on an effort of attention. This explains the fact that time spent in waiting for some one seems so long, and that when the expected person comes, the time of waiting, now thrown into the past, seems very short. Time occupied with uniform work seems much shorter than the same time devoted to a number of tasks which have no connection. The influence of attention enters also here.

We arrive, therefore, at this general result, that the reproduction of states of consciousness depends, as their immediate perception depends, upon the degree of effort in attention. Each representation to be perceived, must accommodate itself to the attention, must enter what we have called the visual point. And just as each impression can be perceived too soon or too late, because too much or too little time is allowed for attention; so a representation, a purely internal state, can be reproduced too soon or too late, according as its reproduction ought to be slow or fast.

To sum up, differences in the duration of perception and reproduction may be referred to the two following principles:

1st. In reproduction, the time necessary for the complete passage of the attention from one state to another is considerably increased. In cases of real impressions, we have seen that this time is hardly a second since, for two sounds separated by an interval of one second, the lengthening is zero. The passage then of the attention from one state to another takes less than a second. On the other hand, if a short interval be left between the impression and its reproduction, the time may reach several seconds.

2d. The difference between immediate perception and reproduction increases with the interval of time between internal states and with the interval between the impression and the moment of reproduction.[1]

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[1] When we compare two intervals of time, and the second differs from the first (is longer or shorter), it necessarily happens that at this moment of comparison the first interval is given only under the form of inep-

VII. It remains to examine the last case. In all the preceding we have been concerned with the determination of the variations of *physiological time* (that is the interval which elapses between the excitation and the sign of reaction) in the different conditions described. Here we arrive at a determination still more exact.

We have seen that Donders proposed to measure the time necessary for a very simple intellectual operation, and called it the solution of a dilemma. It is the same problem that Kries and Auerbach have just taken up.[1]

To understand their method we must provide ourselves with two lights, one blue and the other red, to be brought forward one at a time indiscriminately. The subject is to react only when he sees the light agreed upon beforehand. Under this condition, the reaction is delayed. This delay must be attributed to an intellectual operation, an act of discernment[2] between two simple perceptions, terminating in a conclusion. The duration of this act of discernment is to be determined. To do this, experimenters have been obliged: 1st, to determine the personal equation, that is, the entire duration of the reaction, the excitation remaining constant: 2d, to determine the duration of the reaction, the excitation changing. The difference between these two

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ory; consequently, it is subject to the error that belongs to reproduced states. Different experimenters, Mach, Vierordt, Hering, have shown that the apperception of this difference of duration varies between a maximum and minimum; but their experiments do not agree. More recently (1882), Wundt, Kollert and Buccola have made new experiments to ascertain with what approximate exactitude we reproduce in memory the succession of external events. From 1790 experiments, Buccola concludes that the errors are proportional to the duration; the time estimate becomes less exact in proportion as the lengths of time are greater. For details of experiments and results, see *La legge del tempo*: p. 321 and fol.

[1] *Archiv. für Anatomie u. Physiologie*, 1877, p. 296.

[2] What Bain calls *discrimination*.

quantities gives the duration of the act of discernment. Their experiments, using different orders of perception, give the following results:

	Auerbach seconds.	Kries seconds.
Localization of tactile perceptions (i. e., distinction of different parts of the tactile organ)	0.021	0.036
Distinction between two tactile excitations,		
When feebler	0.053	0.105
When stronger . . .	0.022	0.061
Discernment of a high note	0.019	0.049
" " low note	0.034	0.054
" between a tone and a noise . . .	0.023	0.046
Localization of sound	0.015	0.032
Discernment between two colors	0.012	0.034
" of the direction of light	0.011	0.017
" of distance of objects seen	0.022	0.030

From this table, Auerbach's mean duration of the act of discernment is 0.026, and that of Kries, 0.049, that is, the latter is almost double the former: consequently the duration of psychic operations may vary greatly with the subject.[1]

III.

The foregoing reproduces, without important modification, the exposition of our first edition. We have changed it little, because during the last six years psychometric study has been very active, and it is well to point out the road which it has traversed. Wundt has established a psychophysical laboratory at Leipzig, where, with the help of his students, he has arranged the new experiments which we are now about to consider. They are recorded in various articles published in a special organ, the *Philosophische Studien*. To the present, six[2] brochures have appeared.

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[1] For a criticism of these results, see Richet, *Revue philosophique*, VI, p. 395. The author thinks that a duration so small (about 3 hundredths second) is altogether below the limit of the experimental error.

[2] Now ten, January, 1886.—Tr.

Besides the German work, experiments have been conducted in Italy, especially by Buccola, which will be spoken of incidentally.

In the first period of psychometric study, investigation was confined to the *simplest* states of consciousness (duration of sensation, reaction, discernment).[1] At present research is being made in the *most complex* forms of mental activity: duration of associations of different kinds, volition or choice, pathological variations, &c.

We will commence with the question as to the time of the perception of representations which are composite, but whose elements are so homogeneous that the product still remains relatively simple. In order to see the increase of the duration of the perception as the complexity of the representation increases, we must cause the latter to grow regularly. Wundt employs visual representations, printed numbers varying from 1 to 6 figures. Of the results reached by many observers, I transcribe the most important. The unit is always a second:

1 figure.	2 fig.	3 fig.	4 fig.	5 fig.	6 fig.
0.324	0.339	0.314	0.474	0.687	1.062
0.308	0.358	0.386	0.491	0.627	1.079

These numbers are taken from one hundred and twenty experiments made at different times: the first series during one month, and the second, the next month. With most observers, the differences are small, while the numbers are of one, two or three figures; but when they reach four to six figures, we find them important.

I will mention, also, the researches relating to the area or circle of consciousness (*Umfang des Bewusstseins*). How can it have simultaneous states? It is a question that has been much discussed, especially by Herbart and his disciples, Waitz and Lange. But it is clear that internal observation can not answer this difficult question: we must rely upon the experimental method to reach it. Wundt takes a series of simple impressions: the beats of a pendulum interrupted regularly by the ring of a bell. We find that there is a certain rapidity which gives the maximum of perception. If it increase or diminish, the conditions become less favorable for the experiment. "We find that the most favorable rapidity is that which gives an interval of 0.3″ to 0.5″ between the impressions. The maximum number of impressions that can form a series in consciousness is as high as 12. We may say, therefore, that twelve simple representations give the maximum area of consciousness for successive and relatively simple states." We reach the same result for tactile sensations, but we cannot retain as great a number of impressions unless they present rhythmic form.[1]

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[1] Quite lately (1883) the duration of olfactory perception has been measured for the first time almost simultaneously by Beaunis, in France, Buccola in Italy, and Moldenhauer in the laboratory of Wundt. The three experimenters have reached results that agree in the main. They are to be found in the *Revue philosophique* for May, 1883, pp. 566 and 577.

We now reach more complicated researches. Their object is to determine the *duration of association*, that is, the time of the reproduction of a remembrance (*Erinnerungsbild*) called up by any perception. The four experimenters are Wundt, Stanley Hall, Besser and Trautscholdt, the author of the article.[2] The four initials W. H. B. T. will designate these persons in the tables which follow.

As a preliminary to the question of quantity, a very minute classification of associations is made as to quality, since the experiments must be performed separately for each distinct group of associations. Trautscholdt, as also Drobisch, Herbart, and Taine, makes two great classes: association external or indirect, and internal or direct.

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[1] *Grundzüge*, II, p. 212. These researches were reported by Dietze in an article in the *Philosophische Studien* (II, 3), recently published (January, 1885).

[2] *Philosophische Studien*, I, p. 213 and fol.

We will give briefly the leading features of his classification, which contains, in the original, no less than 42 divisions and subdivisions:

I.—*Internal Association.*

A.—Association of simultaneous representations.

1st. Association of the parts of a single representation (example: association of whole and parts, and of parts with one another).

2d. Association of representations co-existing in an independent way.

B.—Association of successive representations.

1st. Association of successive auditory impressions (in particular, association of words).

2d. Association of successive impressions of sight and the other senses.

II. *External Association.*

1st. Association by eminence (*Ueberordnung*) and subordination (association with a more and less general representation).

2d. Association by co-ordination (resemblance and contrast).

3d. Association by relation of dependence (causality, finality).

In the following table may be seen the distribution of cases to the four experimenters in these different forms of association:

From a total of 100 cases:	W.	B.	H.	T.
I. *Internal Association*	48	64	31	73
A. Simultaneous "	20	23	16	33
1st. Whole and parts	9	8	2	7
2d. Independently co-existing representations	11	15	14	26
B. Successive association (words)	28	41	15	40
1st. Completion of a word	19	20.5	12	21
2d. " " phrase	9	20.5	3	19

II. *External Association*	52	36	69	27
1st. Subordination	14	10	26	15
2d. Co-ordination	36	24	37	8
3d. Dependence	0	2	6	2

We will remark, to help the reader, that taking the column W. of the table (experiments of Wundt), we see that in 100 cases there are 48 internal associations, 52 external. The 48 internal associations are made up of 20 simultaneous, 28 successive, and the 20 simultaneous are made up, as the table shows, of 9, 11, and so on.

We must remark, also, that the small number of associations of words by Stanley Hall is due to his want of familiarity with the German language.

Trautscholdt examines, then, the "part that subjective moments play in association." Experiment shows that the two most important are habit and vividness. He recalls on this subject the researches of Galton (published in *Brain*, 1879), which show that the associations of youth are most firmly fixed, and that about half of our associations date back to that period. Wundt reaches similar results. He divides his life into three periods: childhood, to sixteen or seventeen years; from seventeen to twenty-five; the later period. Of forty-four associations, he finds that twenty-five belong to the first, fourteen to the second, five to the third period: that is, 57, 32, and 11 per cent. respectively.

The second part of the article is devoted, not to the number, but to the duration of associations, the time required for their formation. The author classes his experiments and results under the following heads:

1st. Time of simple reaction: time from the action of a simple auditory impression to the reaction by voluntary movement.

2d. Time of reaction of a word (*Wortreaction*): time from a verbal impression to the voluntary reaction which follows the apperception of the word.

3d. Time of the discernment of a word (*Wortunterscheidungszeit*). The two preceding experiments being in the same conditions as far as possible, subtraction gives the time necessary to distinguish a word; we take quantity (1) from quantity (2). The time necessary to the transmission of the impression to the brain, and for the reaction from the brain to the muscles, being the same in the two cases, the third result may be readily deduced from the two.

4th. Time of reaction in association: time that elapses from the impression of a word to the reaction that follows the apperception of an idea awakened by association. This time is obtained by subtracting the time of the reaction of a word (2) from the total time of the experiment. Examples of associations in point are: zero—infinity; market—market-place; letter—portfolio (*Brief—Brieftasche*).

I. *Time of the reaction.*—The initials, as before, indicate the four experimenters:

	W.	B.	H.	T.
	0.196	0.108	0.143	0.116
Mean variation	0.009	0.012	0.017	[illegible]
Number of experiments . .	40	104	32	[illegible]

The average of the four is 0.141″, agreeing with the average of other experimenters: Hankel, 0.150; Hirsch, 0.149; Exner, 0.136.

II. *Time of the reaction of a word:*

	W.	B.	H.	T.
	0.303	0.285	0.280	0.173
Mean variation . .	0.026	0.036	0.029	[illegible]

III. *Time of the discernment of a word:* Obtained, as was said above, by subtraction.

W.	B.	H.	T.
0.107	0.177	0.137	0.057

IV. *Time of an association:* It will be remembered that we must obtain the total reaction, and subtract the numbers of (2).

	W.	B.	H.	T.
Total duration	1.009	1.037	1.154	0.896
Mean variation	0.128	0.099	0.175	0.168

The time necessary to the association is then:

W. 0.706	B. 0.752	H. 0.874	T. 0.723

Throwing out the results of Stanley Hall for the reason given above, we have as the average 0.727″.

The third part of the monograph is devoted to "Researches on the duration of the judgment of subordination." They deal, it seems, with a psychic process rather more complicated than simple association. A word is spoken and the observer reacts when he conceives an idea in logical subordination to the word concept.

Duration of the total reaction .	W. 1.148	B. 1.014	T. 0.898.
Mean variation	0.148	0.197	0.120.

To reach the real time of the subordinate judgment, we must subtract, for each observer, the time of the reaction of a word. We have:

W. 0.845	B. 0.729	T. 0.725

The average is 0.766″, greater than the association time by 0.04″.

The author remarks that the time necessary for the formation of judgments differs according to their nature. He makes three classes:

1st. A shorter time, when the judgment relates a concrete term to its genus. Examples: salamander—animal, 0.523; lime—oxide, 0.488, etc.

2d. A longer time, when the subject is not concrete. Example: paralysis—physical disease, 1.750.

3d. Maximum time, when the judgment relates an abstract subject to a general concept. Example: glory—

a kind of fame, 2.023; art—æsthetic activity of man, 1.899.[1]

Taking one of the three observers, B, we see that the time varies with the three classes of judgments:

1st. = 0.625, 2d. = 0.876, 3d. = 1.250.

Trautscholdt thinks that the true mean is to be obtained from the last two categories, in which the judgments are more abstract, and finds it:

W. 0.865 B. 0.917 T. 0.839,

and as general average 0.874″, which is higher than the average above (0.766″), and exceeds by nearly one-tenth the time of association (⅑).

Variations in duration have also been studied in pathological states (intoxication, mental diseases, &c.). As early as 1873, Exner, in *Pflüger's Archiv*, showed that after drinking at once two bottles of Rhine wine, the time of the reaction went up to 0.1904″–0.2969″, although he had the feeling of reaction in the last case much sooner. These experiments were repeated with the same result by Dietl and Vintschgau, and by Kraepelin under the direction of Wundt. The last used nitrite of amyle, ether of ethyl, and chloroform, and published the results of his experiments in two long articles (*Philosophische Studien*, I, Hefte 3 u. 4). He found that discernment and choice taken together represent, in a certain measure, a psychic act which in its duration, shows no notable individual difference. In the first period of the action of alcohol choice is quicker; in the second, discernment is quicker; and the simple reaction, in the act of choice, becomes longer throughout.

Some words, in closing, on mental diseases. Obersteiner, in 1879, found that a subject whose normal reaction was

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[1] It is important to notice that in all these experiments the word given is a German monosyllable: *Milch*, *Kalk*, *Ruhm*, &c.

0.133, in a state of fatigue and somnolence gave 0.183; and with a headache, 0.171; in the first stage of general paralysis 0.166, and at the last stage at which experiments were possible, from 0.281 to 0.755. Finally we must mention also the long investigations made by Buccola in the lunatic asylum at Reggio and the Psychiatric Institute at Turin. He experimented on imbeciles, idiots, demented, deluded and melancholy persons, monomaniacs, and epileptics. Outside of cases of abnormal excitement, he found the duration of perception always more or less lengthened. With imbeciles and idiots the retardation is very great.

It is not possible to examine here all the recent works on psychometry.[1] We have only tried to explain the method and principal results. It shows that the facts of consciousness, like all other phenomena, have exact duration, variable and measurable. No doubt all would have admitted, especially since Kant, that internal phenomena are distinctively time phenomena; but this vague expression left thought in a region so mystical that it has seemed inaccessible to all time measurement.

Yet at the beginning of the century the illustrious physiologist, J. Müller, maintained that the time of the reaction of a sensation in movement is infinitely small and incapable of measurement (*unendlich klein und unmessbar*).

And perhaps it may be asked, when all this work, so tiresome, minute, and destitute of literary attractiveness, is done, is it worth what it costs, whither does it conduct, and does it throw any light upon thought and its nature? We may answer at once that it is worth more to solve small problems than to debate unceasingly great questions whose solution is impossible. But is the question we are occupied with really so small? It is evident that it teaches us nothing of the ultimate nature of thought: observers do not propose to themselves this end, when they treat this problem from the standpoint of experience. Science has nothing to do with such insoluble problems. Its work consists in resolving each whole called a fact, and submitting to experiment and measure all its constituent elements. It can do nothing more. Scientific knowledge of a fact is the complete determination of its relations: what remains is the business of metaphysic.

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[1] A complete study of the question is to be found in the important work of Buccola *La legge del tempo nei fenomeni del pensiero: saggio di psicologia sperimentale*, 1883. Milan, Dumolard. (*Biblioteca scientifica internazionale.*)

The process here is that pursued in every science. The psychic fact—complex though it be—is studied in one of its constituent elements: variations in duration. It would be more profitable, no doubt, to penetrate other and more essential conditions of thought, such as the physiological variations of nerve structure; but each conquest opens the way for farther progress and offers a new outlook. The determination of the velocity of sensor and motor nerve action appears to be of secondary importance only for psychology; and yet by it the psychic fact is driven nearer its ultimate stronghold and the subterranean approaches, so to speak, are opened up. Instead of the subjective method hitherto exclusively employed in the study of the succession of sensations and ideas, we employ an objective method which, among other results, exposes the error of the supposition that the internal order of representations reproduces immediately the external order of phenomena. The experimental method has also shown that consciousness is a discontinuous series of states, separated by short intervals, together with the manner and conditions of their variation.

We have given these facts, not as exaggerating their definitive importance, but as seeing in them the corner-stone of a new structure, and in the method employed a sure promise of its successful erection.

We can not close better than by quoting these reflections from Buccola: "It seems that this rigorous branch of physiological psychology, psychometry, is destined to solve many of the old problems. Its real and legitimate importance in dealing with mental phenomena does not rest, as is generally believed, in a simple search for numbers. Sustained rigor of method and experiment must be employed to apply to these numbers the test of analysis and to derive the different moments of the psychic process. To this point the most careful and unprejudiced study must be directed in the future" (work cited, p. 33).

CHAPTER VIII.

CONCLUSION.

I.

We have grouped under different titles and with the names of men distinguished in this department, the researches from which, it seems, most can be deduced for the positive study of psychological questions. They are, as we have seen, of recent date. After Kant, metaphysic reigned in Germany for half a century, and all science of the phenomena of consciousness was forgotten or despised. The reaction which followed was not more favorable to psychology. Men continued to treat it as an illegitimate child of metaphysic and wrote books which were epitomes of artificial, profitless, and insoluble questions; discarded altogether a positive basis of fact, and lost themselves in the interminable mazes of pre-established harmony, physical flux, occasionalism, materialism, and pantheism, in all their forms. Men seriously discussed the relative merit of "traducianism" and "creationism." Instead of doctrine, we find history, an enumeration of conflicting views, whose only effect is to make the conscientious reader regret that he has lost so much time.

Yet even then, scientists, as it were by chance and through the study of details, were preparing for the birth of scientific psychology. The first workers stirred up others, who pursued the same end by different routes. We have already insisted many times upon the method which they were compelled to employ, and it would be superfluous to give here a list of their names and works. Under a guise of history, our object is dogmatic. We have endeavored to bring before the public a definite way of dealing with the phenomena of consciousness and to show the results obtained by the method of the natural sciences. Only what is new has arrested us. So, in conclusion, we will pass rapidly in review some works which are of lesser importance, it is true, but which it would be unjust to leave unmentioned.

HORWICZ.

I. It is not our intention to give a detailed exposition of the theories of Horwicz. We wish only to indicate his place in the contemporary movement and bespeak briefly his part.

Horwicz is not a professional physiologist. Nor is he an ideologist; that is, his psychology is not simply an analysis of ideas and words, after the manner of the eighteenth century, and the method of some representatives of the Scottish school, as Stuart Mill. He proposes to borrow contributions from physiology and make them the point of departure in his psychological study. The title of his work,[1] *Psychological Analyses upon Physiological Bases*, is well chosen and expresses his object exactly.

Setting aside his theory of knowledge—the most questionable portion of his work, in our opinion, and least suited to his turn of mind—we find in him the highest qualities for psychological study; delicacy, penetration, sometimes depth, ingenuity in framing hypotheses, and aptitude in construing observations and details. Unfortunately, he often lacks order in the general course of his exposition. It is hard to connect clearly the different subjects of which he treats, many of them being discussed again and again under different headings. The misuse, moreover, of divisions and subdivisions tends to embarrass the reader.

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[1] *Psychologische Analysen auf physiologischer Grundlage: ein Versuch zur Neubegründung der Seelenlehre.* 1st part, Halle, 1872, 2d part (2 vols.), Magdeburg and Halle, 1875 and 1878.

His doctrine can not be reduced to a system or connected whole; but be it far from us to reproach him for this. Psychology at present demands, above all things, a study of details. Yet in this collection of analyses, we find it possible to disengage two general principles whereby to characterize the psychology of the author: 1st, he employs the physiological method; and 2d, he assigns to feeling the leading part in the psychic life.

The data of consciousness, says Horwicz, serve only as preliminaries; they afford only an ordinary and rough view of the activity of mind. They must be supplemented by physiology. Physiology presents the organic conditions of psychic phenomena, and is thus not a useful accessory alone, but "the regular vehicle of research, the thread of Ariadne." The author does not proceed as many others, who make this avowal and then hasten to betake themselves to the old method, or content themselves with paying a Platonic tribute to the natural sciences by scattering a few facts throughout their pages. He, on the contrary, makes a persistent effort to realize the spirit of the biological sciences by the ultimate reference of all his explanations to them. "A psychology," says he, "which professes to make the great discoveries of physiology useful to the science of the soul must employ experiential data throughout its entire domain. It must not be content, with the old psychologists both empirical and speculative, with arranging facts or explaining them in the line of *a priori* construction. To take a particular case, it does not suffice to show that some sensations are to be referred to objects without (sense-perception), and others to the organism and its states (organic sense); but we must know, if possible, the conditions, organic or otherwise, under which the two orders of sensation are produced."[1]

Psychological questions take form for him strictly from the point of view of observable phenomena, and he finds in the metaphysical psychology only vanity and nonsense (*völlige Eitelkeit und Tollheit*). "It must not be expected that our method will attain to ultimate questions. What is the soul, substance or accident; what becomes of it at death; what relation does it sustain to body; all these are problems which are in no wise to be considered at the outset, at least, if they are ever to be brought into our investigation. Our warfare against materialism has no other object than to keep the way open to true scientific research, and in cases in which such research has no issue, to distinguish it from subjective beliefs and opinions, religious and moral. We employ the word 'soul,' therefore, not in the sense of an immaterial substance whose existence is to be proved, but simply as the collective denomination of the phenomena and processes called psychic."[2]

This being the general spirit of the method of Horwicz, let us see its application to a particular case: the study of feeling. To him, "*feeling is psychic activity in its simplest, most elementary, and most general form, and this activity is point of departure for all the other psychic processes.*" Feeling, therefore, plays the leading role in his psychology.

Four different views have had currency among psychologists as to the essential nature of feeling:[3]

1st. What is advantageous to the organism is felt to be agreeable; that which injures it, disagreeable (Wolff, Kant, Lotze with modifications).

2d. Feeling arises from contrast (Stiedenroth, Wundt).

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[1] *Psychologische Analysen*, I, p. 100.

[2] Ibid., pp. 124, 125.

[3] Ibid. II; 2d part, p. 31, and fol.

3d. The basis of all desire is lack, privation (Schopenhauer, Hartmann).

4th. Feeling results from molecular equilibrium in the nerve substance, and is therefore physiological.

No one of these theories is exclusive; each implies the others, partially, at least. The author shows, in a detailed criticism, that no one of them is sufficient to explain the nature of feeling. Yet of them all the last is most nearly his, as he gives the following as one of the principal results of his critique: There is for every sentient organ, and for the organism in general, a *state of equilibrium*, about which the feelings gravitate, in such a way that its suspension is felt to be disagreeable, and its continuance agreeable (p. 43).

But there is no stable equilibrium in the nerve substance: cellular equilibrium is unstable, entirely relative. It can not be considered, therefore, as a normal state, and we are led to admit that what we feel is not a *state*, but a *change* in the nerve substance; in other words, the essence of feeling is change, a becoming.[1]

If, conformably to the physiological method, we enter farther into the nature of the nerve phenomenon with a view to a better understanding of the psychic, we ascertain that this state of unstable equilibrium, with its continual changes, favorable and unfavorable,—the author designates them by the words *contrasts*—answers to a more general law of the entire organism: "Objective molecular equilibrium has a subjective psychic correlate, *habit*: to contrast, the new and unaccustomed corresponds" (p. 50). To go still further, we find two molecular processes in the organism: one, the storing up of disposable work by the formation of complex combinations; the other, the disengaging of active force by the dissolution of these combinations: acquisition and outlay—molecular work negative and positive. These correspond to the subjective processes of self-conservation (*Selbsterhaltung*) and change; habit and contrast. This parallelism, questionable perhaps in its rigorous sense, is exact in a general way, habit corresponding to the preponderance of the negative process, contrast to that of the positive.[1]

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[1] Work cited, part 2, vol. III, p. 41. The author cites in point Léon Dumont. The view of Herbart, given above, also comes to mind.

From all these considerations, the author concludes that "the essence of feeling is self-conservation, that is, the mode of reaction with respect to change, a reaction that is distinguished from purely physical reaction by autonomy or spontaneity" (p. 51). Pleasure arises from strength in the psychic life; pain from feebleness and inertia (p. 55).

Feeling is closely connected, therefore, with the most elementary vital processes.

"My analyses," says Horwicz, "have a very definite end: to refer to a fundamental psycho-physical element the totality of the psychic processes." We have just given an example. And if it be objected that only the feelings of a lower order, the *sinnliche Gefühle*, maintain this intimate connection with the laws of life, the author replies that the higher feelings are to be referred to the lower, for they are complexes only, and consequently are to be referred by analysis to the nerve processes (p. 66).

We will not follow the author into his classification of feelings; it has nothing new,[2] and has been severely criticised: it is better, following the plan we have adopted, to show by an example the ruling part that he assigns to feeling in the intellectual life. We will take the fact of reproduction or memory.[1]

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[1] To sum up these terms, negative and positive work, acquisition and outlay, habit and change, equilibrium and contrast, represent different aspects of one and the same process considered in the order of life, feeling, or intelligence.

[2] He classes them as feelings of sense, æsthetic, intellectual, and moral.

As a condition of reproduction it is necessary that a trace or residuum, to be utilized by memory, remain in the nerve elements. Can this residuum be explained, as Volkmann thought, by the law of persistence or conservation of energy? Horwicz does not believe that the persistence of representations consists in simple mechanical action, because sensation, which is a reaction of the soul, differs in nature from physical reaction in that it implies spontaneity. A sensation conserved is a tendency that persists.

Feeling (*Gefühl*), to Horwicz, is the cause of the suspensive action whereby representations are held in an unconscious state, and is, at the same time, "the vehicle of the association of ideas, that is, the cause of their return to consciousness." The basis of the fact of the conservation of residues is a persistent tendency to movement, a tendency to respond to an excitation determined by a determined movement. This the essential nature of memory (the persistence of a tendency to movement), although often concealed, is sometimes manifested to us in a striking way. Many of our memories are accompanied by movement. In cases in which there is no movement proper, some analogous phenomenon appears: for example, if I picture a lemon to myself, the idea of eating the fruit produces a secretion of saliva, which can be considered the equivalent to movement.

The question here is only of the simplest cases, that is, of the forms of feeling which accompany sensation and are followed by movement. The higher forms, like theoretical ideas, escape our analysis. Yet we can suppose that the case is analogous with the more complex forms.

Our theory, adds Horwicz, accords well with the well-known fact that the feelings themselves have a very feeble power of reproduction (we have, for example, only a feeble representation of a past tooth-ache), and, indeed, explains it. At first sight, this seems a contradiction; for if feeling plays the part we assign to it, how is it that it is not most readily reproduced? "This exception proves our rule. It is not, in fact, the feeling itself that is the elementary factor of memory; but it is feeling in its necessary relation to movement and the manifestations which follow. Feeling is the mediator, not the immediate ground of association. This explains the fact that feeling rules and determines the internal combinations, and at the same time is itself with difficulty reproduced."

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[1] *Psychol. Analysen*, II, p. 276 and fol.

This function of feeling explains a point in respect to the laws of association, also, which has been hitherto obscure, and indeed, inexplicable.

The new psychology reduces these laws to two: 1st, law of contiguity in space and time; 2d, law of resemblance (identity, analogy, contrast). It is plain, however, that contrast can not enter in the action of the law to which it is assigned, without violence. We are compelled, on this hypothesis, to say that contrast is a kind of resemblance, that is, that there is no association by contrast. For if contrary ideas awake each other only by what they have in common, analogy and not contrast is the ground of the association. A desert ought to make us think of other deserts, and not, as is often the case, of fertile country. But this and analogous cases are really explained by the function of feeling. It is a characteristic of feeling that its two opposing forms, pleasure and pain, have a reciprocal dependence. The same feeling is produced sometimes under the form of a tendency to reconciliation, sometimes a tendency to separation. The ideas corresponding to these two contrary forms must, therefore, be intimately connected.

In a general way, feeling to Horwicz is the original psychic fact. Every representation has been once a feeling, and all knowledge is inert and profitless, unless feeling work it up like leaven. "It is very difficult," says Horwicz, "to act on merely theoretical knowledge. All men know very well that time, and health, and money, should be economized; but many do it not. It is necessary, in most cases, that our knowledge be changed into will as food is changed into chyle and blood. An intermediate factor is needed to change knowledge into desire, as diastase changes starch into sugar. This factor is feeling. The idea, accompanied by a feeling, is changed into a desire corresponding to this feeling; otherwise, nothing takes place."[1]

Such are the principal features, to our mind, of the unfinished work of Horwicz. We give them to the reader only as suggestions.

BRENTANO.

(II. In the contemporary movement in psychology, there are two currents which may be characterized as follows:

The representatives of the old psychology, that is of a heterogeneous mixture of facts, descriptions and metaphysical hypotheses;

The representatives of the new psychology, that is, those who exclude all metaphysics and confine themselves to actual phenomena.)

But among the latter, two tendencies must be distinguished, the ideological or logical and the physiological. It is not necessary to mention names. Every reader who has kept up at all with the philosophy of the last fifteen years will recall them himself.

To the first of these tendencies belongs Franz Brentano, at present professor-ordinary in the University of Vienna. He passes in Germany as a disciple of Stuart Mill, who, like himself, has no physiological leaning. And thereby he is distinguished from Horwicz, although he is as clearly empirical.

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[1] *Psychol. Analysen*, I, pp. 152, 153.

"My point of view," says he, "in psychology, is empirical; experience is my only master; but I share with others the conviction that a certain ideal intuition (*eine gewisse ideale Anschauung*) is perfectly tenable from this point of view." In the place of psychologies, we must seek to establish a psychology. "We find already the beginnings of a scientific psychology, modest as yet; but there are signs of a possible development that will bear abundant fruit for future generations."[1]

The first part of Brentano's work is devoted to a detailed study of the question of the nature of psychology and its method.

Psychology may be conceived in two ways: either as the science of the soul—this is the old conception—or as the science of psychic phenomena—this is the new conception. The first has led to the second in this way. It has been often remarked that alchemists in seeking for the philosopher's stone, that is, for the undiscoverable, have found what they did not seek; positive facts, which have given birth and development to chemistry. Metaphysicians have done the same. To them the great problem has been the immortality of the soul. While their seeking has been unceasing and unsuccessful, they have found that for which they did not seek: facts, observations, by which psychology profits anew. In their pursuit of a transcendent problem, they have discovered the laws of reasoning, the association of ideas, the formation of concepts; they have studied the desires and passions. Like the children of the old man in the fable, they sought a pretended treasure buried in the earth, and they found riches of another kind.

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[1] *Psychologie vom empirischen Standpunkte.* Leipzig, 1874 (only the 1st volume has appeared), *Vorwort*, p. 1.

The author shows, on excellent grounds, that the development of psychology is conditioned upon the previous constitution of the subordinate sciences. After defining it as "the science of psychic phenomena," he remarks that this new conception of psychology is entirely unacceptable to the disciples of the old school. Whether there be a soul or not, it is certain that there are psychic facts. The difference between the two conceptions is this: the old is encumbered with metaphysical hypotheses, and the new is entirely free from them. The latter is occupied with facts common to all schools, while the former is colored by the claims peculiar to its own. The comparison certainly casts no credit upon the old psychology.

The practical importance of the scientific psychology is indisputable. The author, who insists properly upon this point, shows such confidence in future results that he does not hesitate to call psychology "the science of the future."

The object of psychology thus fixed, we turn to the question of method. It is here that Brentano, while maintaining his empirical position, separates from the physiological school. The principal source of psychology to him is internal perception (*innere Wahrnehmung*), which must be carefully distinguished from internal observation (*innere Beobachtung*). The author attaches the greatest importance to this distinction. Observation, says he, applies only to external objects; internal observation is impossible. It is the confusion of these two distinct states, observation and perception, that has given rise to the objections brought against the subjective psychology by Comte in France, Maudsley in England, and Lange in Germany.

Brentano admits, indeed, that by memory a retrospective study of the states of consciousness is possible; but, since memory is subject to illusions and errors, psychology is at a great disadvantage in the race with the other natural sciences.

Besides the data of internal perception and memory, the author, as every one else, indicates as helps to psychology, the study of language, human conduct, history, mental diseases, etc.

Setting out with these facts, we seek to rise to laws purely empirical. Yet the author does not admit that the higher laws of psychology should or can be deduced from physiology, and he criticises Horwicz and Maudsley on this point at length. Maudsley has made a lively attack on the subjective method in the introduction to his *Physiology and Pathology of Mind.* He might have said what follows, written against Stuart Mill, most appropriately of Brentano: "Mill was wrong in neglecting the physiological method, which would have brought such fruitful results to psychology; in imagining that, by the old process, based upon internal perception, he could attain that which Plato, Descartes, Locke, Berkeley, and so many others, have failed to attain. We have the sure conviction that thousands of men like Mill can not do what these great men have failed to do; while if he had employed the material furnished by the new method, which was not at the disposal of his great predecessors, he would thereby have acquired better results than they all."

Brentano also criticises the work of Weber, Fechner, and Wundt, in psychophysics; not that he disowns its value, but because he is opposed to all attempts at quantitative determination in the order of psychic phenomena. He reaches this conclusion: that psychology must rest content with *empirical* laws.

The second part of his book treats of psychic phenomena in general. Their essential character to Brentano is that they are *representative:* in other words, psychic state = representation. On this point he approaches Herbart: "All psychic states are representations, or are based upon representations." This leads him to a more and more exact determination of this representative character.

Wherein does it consist? In the relation between a psychic phenomenon and its object. It is generally maintained that every intellectual act supposes an object; intelligence is objective: but to feeling, to sensibility in general, we do not attach an objective character. On this point, Brentano recalls Hamilton, who argued this distinction at length; he rejects it as erroneous. "Joy, hate, love," says he, "are always related to something."

If we admit this view in regard to feeling, it follows that the character of "intentional existence"—as the author expresses it, borrowing the term from the scholastics—is to be found in all psychic activity; indeed, is its fundamental characteristic, since the intellectual states and the desires necessarily relate to something. "Every psychic phenomenon is related to an object; without the object nothing of the kind exists."

This point established, the author passes to the study of consciousness in general, and opens a campaign against the unconscious. He makes attacks especially upon Hartmann and "his arbitrary *a priori* speculations." But, in a general way, it would be difficult to reconcile the ideological method of Brentano with the hypothesis of an unconscious activity of the soul, for internal perception knows only its own domain and never leaves it, and if psychology is rigorously confined to the limits of consciousness, we are false to our psychology, when we overstep these limits.[1]

The third part has a classification of the phenomena of consciousness. Brentano makes three classes or fundamental forms of psychic activity: 1st, the representation; 2d, the judgment; 3d, tendency and desire, or, more simply, love and hate. This division is unexpected enough, but the author himself does not apologize for its novelty. He gives at length (chaps. VII and VIII) his reasons for making an essential distinction between the representation and the judgment, and for making feeling and will originally one. The remainder of the work is to be devoted to a detailed study of these three groups.

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[1] He explains and discusses four hypotheses, which, according to him, are capable of being advanced in favor of unconscious psychic activity. This discussion does not seem to be above criticism: but it is long and profound, and whatever one's opinion be, he should read it. See work cited, pp. 131–176.

It is impossible to pass just judgment upon a book of which only half has been published. We have only tried to show in what respect Brentano, while holding fast to empirical psychology, is separated from the group of physiologists. The impression we gather from the study of his work is, that although the ideological school may show more delicacy and aptitude in analysis than the physiological school, and, although they confine themselves more closely to what is strictly psychological, yet their method leads them into serious mistakes; arbitrary classification, too much reasoning, and too little fact.

III. Besides more extended works, there are some recent monographs that should be mentioned in passing, as showing the extending taste for psychological study in Germany.

The Vienna anatomist Stricker, in short discussions on consciousness, language, the representation of movement, and the association of representations,[1] has made important contributions to the study of movement and its integral and necessary part in the psychic life. We may also mention Kussmaul, who, in his book *die Störungen der Sprache* (recently translated into French), has given us a very interesting monograph on the disorders of language.

A naturalist, G. H. Schneider, devoted to the theory of evolution and familiar with the doctrines of Darwin and

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[1] *Studien über das Bewusstsein. Studien über die Sprachvorstellungen. Studien über die Bewegungsvorstellung. Studien über die Association der Vorstellungen.* Vienna, 1879-1883.

Hæckel, gives to the public a chapter in comparative psychology, tracing the development of will from the lower forms of life up to man.[1] Feeling, in its most general sense, is the basis of the psychic life. Feeling has its cause in the organism, that is, in the vital animal processes, and the different kinds of feeling are conditioned upon differences in the corporeal organization. The problem of the origin of feeling, therefore, has its root in the problem of animal life. Just as among the infinitely diverse chemical combinations found in nature, there is one which gives rise to conditions that produce a living substance capable in turn of producing other living substances; just as, in a word, life is only a special case in an infinity of cases: so feeling is only one case among innumerable possible combinations; and it is not more difficult to conceive of feeling combinations born of combinations not feeling, than of living beings born of things not living. Quite recently Schneider has studied pleasure and pain from the same evolution-point of view, and drawn practical moral and social conclusions which are very optimistic. To him both pleasure and pain have positive value. The whole question is to know their function when taken together; and this question is solved by the ultimate law of biological evolution, which would be impossible without the predominance of processes by which progress is assured.

We must mention also the experimental researches in cerebral localization of Meynert, Fritsch and Hitzig, Exner, Munk, &c. The psychological interpretation of these experiments, however, is very incomplete and uncertain. And it is far from being exclusively German work.

Outside of the *Naturforscher*, and among the purely philosophical schools, the Neo-kantians, very numerous just now, have best served the interests of the new psychology.

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[1] *Der thierische Wille* (1880). *Der menschliche Wille* (1882).

In general, their work has had a slightly different end, the theory of knowledge; but the *Vierteljahrsschrift für wissenschaftliche Philosophie*, founded in October, 1876, has favored psychological research in its scientific tendency and published important articles in this direction.

II.

While contemporary psychology in England, in spite of many individual variations, has been properly called *associationism*, for the reason that it makes the law of association fundamental in the mechanism of mind, there is no general conception to serve us in grouping the foregoing researches in Germany. As concerns the spirit and method, common to the authors of whom we have spoken, there is only one subject that serves to group their work as a connected whole: it is the subject of sense perception, understanding it in its broadest sense: its immediate conditions and its immediate consequences.

Let us try to sum up under this principle the leading results of the German psychology, neglecting all that does not properly belong to it.

The first striking point is the study of the *elements of simple sensation*. The elements of the simple—this seems a contradiction. But it is one of the rewards of the physiological psychology that it has shown that the simple in consciousness is really complex, a synthesis. It is true that the experiments of physicists had long before prepared the way for this conclusion; and it would have been reached sooner if psychology, confined to the Ego, and exclusively given to internal observation, had not looked upon these researches as foreign and unprofitable, as causes *of distraction* which it was bound to ignore. While physicists were very far from the phenomena of consciousness and psychologists were ignoring the matter, physiologists were led, by their experiments, to the very point at which the physiological and mental meet; and thus made a study, sometimes all unconsciously, of elementary sensation. It is, therefore, just to give physiological psychology—whose principal representatives are in Germany—the credit of having inaugurated an order of research in which more recently psychologists have borne a good part.[1] Helmholtz,[2] above all, deserves signal mention. His studies on physiological acoustics, especially the experiments by which he proved that timbre, the quality which seems so indefinable, is due to complementary notes grouped about the fundamental in definite relations, showed that the immediate physical cause of sensation is a complex group of elements, each of which, in its variations, causes corresponding variations in the sensation.

The lowest state of consciousness, the perception of sound and color; the simplest form of sensation, stripped of all association, all localization,—these are still complex. A sound has pitch, intensity, timbre, corresponding with the number, amplitude, and form of its vibrations. A sensation of color, in the same way, depends upon the velocity of ether vibrations and their wave lengths. Setting aside all hypothesis as to the transformation of nerve phenomena into psychic phenomena, and restricting ourselves to the question of fact, it is not possible to consider as simple a state of consciousness which varies with its immediate conditions. If the impression is different, the nerve processes (probably molecular movement in the nerves and cells) are different, and the sensation is different. Physiological experiment, with the aid of subjective analysis, tends to reveal, in the mental world, something analogous to the atoms of the physical world. It can be certainly said, however, that psychology has no more to do with these elements of elements, than physics and chemistry with atoms; that it is an ultimate question which may be remanded to the sphere of metaphysic; that psychology has only to build upon the elements as they appear, as the physico-chemical sciences build upon matter in its ordinary simplicity and with its elementary properties. But the researches of physiological psychology throw light into the dark laboratory whence consciousness proceeds. For here only two hypotheses are possible: either we must admit with Leibnitz, that "since a hundred thousand nothings can not make something," the so-called simple sensation is made up of a sum of elementary states which are excluded from consciousness by reason of their feeble intensity or short duration; or we must admit that this simple sensation results from a synthesis of heterogeneous elements, and sustains to them the same relation that a combination in chemistry sustains to the elements of matter.

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[1] Herbert Spencer, *Principles of Psychology*, part 2, chap. 1. See especially the excellent study of M. Taine on the elements of sensation. *The Intelligence*, part 1, book III, chaps. 1 and 2.

[2] Helmholtz, *Physiologische Theorie der Musik*, part 1, chaps. 5 and 6.

Whatever hypothesis we hold, we must admit that the states of consciousness known as simple, and which, for *consciousness*, are simple, are in fact complex. The decisions of consciousness appealed to so often by psychologists of a certain school as to an ultimate umpire, have therefore only a relative authority. It is not an infallible oracle. It is a witness like any other, often deceived and deceiving, and never utters the *dictum* of absolute truth. This is what the physiological psychology teaches us as the result of its investigation of a question which is apparently so modest.

If we pass from the elements of sensation, to sensation itself, or rather to perception, as an act of real knowledge, we find that the German psychology has been most fruitful in dealing with touch, sight, and hearing. It has treated them, after its own method, always in connection with their physical conditions, considering these conditions not as accessories merely, but as essential and necessary data.

In auditory perception, two principal results are to be noted; one, important for psychology, the more complete reduction of sensation to its elements; the other, important for æsthetics, an effort to give a scientific basis to the æsthetic of sound.[1]

In the sphere of touch and sight, the most original investigation has been made upon the *Ortsinn*, the faculty of localization, that is, the processes by which tactile and visual data are located in space. Two important elements enter in this question: *local signs* and *movement*.

The hypothesis of local signs is peculiarly German. Although, as we have seen, it has many forms, yet it is always fundamentally the same. Somewhat vague, and loaded with metaphysic with Lotze, it takes a more definite form in the later publications of Wundt. It still involves, however, many obscure points. Essentially, the position is this; each sensible element of the retina and skin gives to sensation "a peculiar coloring," whereby the mind performs its later work of transforming this qualitative modification, by means of movement, into a relation of position.

The role of effective movement, of simple tendencies to movement, and the accompanying sensations of innervation, has been studied with the care we would expect from a school of physiologists. This subject had never before been treated so extendedly and with so much exactness.

These researches on the localization of tactile and visual perceptions have led German psychologists to a higher question: what is the origin of the notion of space?[2] This problem, which belongs properly to the theory of knowledge, has yet been treated by the method of physiological psychology; theories have been constantly tested by experiment.

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[1] See Helmholtz, *Physiologische Theorie der Musik*, especially the preface and last chapter.

[2] They are concerned, as we have said many times, only with the empirical genesis of this notion.

There are two solutions yet in the field.

Nativists maintain that the order of tactile and visual sensation has its ground in the constitution of the organism, that it is given originally with the organism, and is consequently innate.

Empiricists, basing all upon the influence of association and habit, attribute the fact of tactile and visual localization to experience, both as to development and origin.

Heretofore, the latter theory has constantly gained ground upon its rival, but has never resolved all the difficulties of the problem. Under one form or another, the same inquiry always arises. Can scientific processes show that the simple and intuitive in consciousness is complex and derived? The problem of sensation becomes here the problem of the notion of space. By this marked analytical tendency, German psychology has done much to solve the problem that seems upon its face so easy; to distinguish the fact from its interpretation, the sensation from the inference that accompanies it.

The study of abstract concepts (time, number, etc.) falls outside the province of physiological psychology, and has been made incidentally only. It bears, in general, however, the mark of Kant.

One of the newest and most daring attempts of German psychology is its application of *quantity* and *measurement* to states of consciousness. Herbart made the first essay, systematic, arbitrary, and ambitious in extent. Since his time the mathematical method has given place to the experimental.

Two points only have as yet seemed open to investigations of this kind:

1st. The relation between sensation and excitation—reduced to formula by Fechner in his celebrated logarithmic law, which has been bravely defended, but as bravely contested;

2d. The duration of psychic acts—minutely studied in the following cases:

Impression known, but not determined as to the time of its appearance;

Impression known and determined as to time;

Impression accompanied by another, like or unlike indiscriminately;

Regular series of perceptions in which a new perception is intercalated;

Comparison between the real duration and its reproduction in memory;

Time necessary for the different kinds of association;

Duration of judgment, choice;

Influences and pathological variations.

There is little to say in regard to feeling. It is a question with which physicists and physiologists have less to do.

Yet here the influence of Herbart predominates: feeling is held to be, not an elementary state, but the resultant of a *reciprocal relation* between sensations and ideas. It is not a state, but a *change*.

Quite lately, feeling and will have been studied from an evolution point of view, and connected with the fundamental laws of life.

In this epitome of results, we have said nothing on the subject of method; that has been sufficiently explained. And we have touched upon the essential only, that the ends proposed by the authors themselves might be clearly understood.

THE END.

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